DOCUMENT RESUME

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IDENTIFIERS	Military Curriculum Project; *Supply Occupations

ABSTRACT

Designed to provide knowledge in receiving, storing, issuing, dispensing, and shipping of petroleum products, this course is one of a number of military-developed curriculum packages selected for adaptation to vocational instruction and curriculum development in a civilian setting. The course consists of three annexes covering 219 hours of instruction. Annex A, General Petroleum Subjects, provides a knowledge of general subjects required of the petroleum supply specialist. Annex C, Class III Supply Point Operations, provides a knowledge of methods of petroleum supply, and operation and operator maintenance of petroleum distribution and dispensing equipment used in class III supply points. Annex D, Terminal Operations, provides a knowledge in terminal operating principles, procedures, practices, and in operation and operator maintenance of terminal equipment. Printed instructor materials include a plan of instruction detailing the teaching steps by the units of instruction, criterion objectives, the duration of the lessons, references, and instructor's guide for each annex. A course manager's guide contains additional references and objectives. Student materials include three study guides with text information, objectives, review exercises, and references. Two technical manuals are appended. (LRA)

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ED19577

Military Curriculum Materials for Vocational and Technical Education

PETROLEUM SUPPLY SPECIALIST
19-4

CE 027 444

THE NATIONAL CENTER
FOR RESEARCH IN VOCATIONAL EDUCATION
THE OHIO STATE UNIVERSITY
1960 KENNY ROAD • COLUMBUS, OHIO 43210

MILITARY CURRICULUM MATERIALS

The military-developed curriculum materials in this course package were selected by the National Center for Research in Vocational Education Military Curriculum Project for dissemination to the six regional Curriculum Coordination Centers and other instructional materials agencies. The purpose of disseminating these courses was to make curriculum materials developed by the military more accessible to vocational educators in the civilian setting.

The course materials were acquired, evaluated by project staff and practitioners in the field, and prepared for dissemination. Materials which were specific to the military were deleted, copyrighted materials were either omitted or approval for their use was obtained. These course packages contain curriculum resource materials which can be adapted to support vocational instruction and curriculum development.

The National Center Mission Statement

The National Center for Research in Vocational Education's mission is to increase the ability of diverse agencies, institutions, and organizations to solve educational problems relating to individual career planning, preparation, and progression. The National Center fulfills its mission by:

- Generating knowledge through research
- Developing educational programs and products
- Evaluating individual program needs and outcomes
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FOR FURTHER INFORMATION ABOUT
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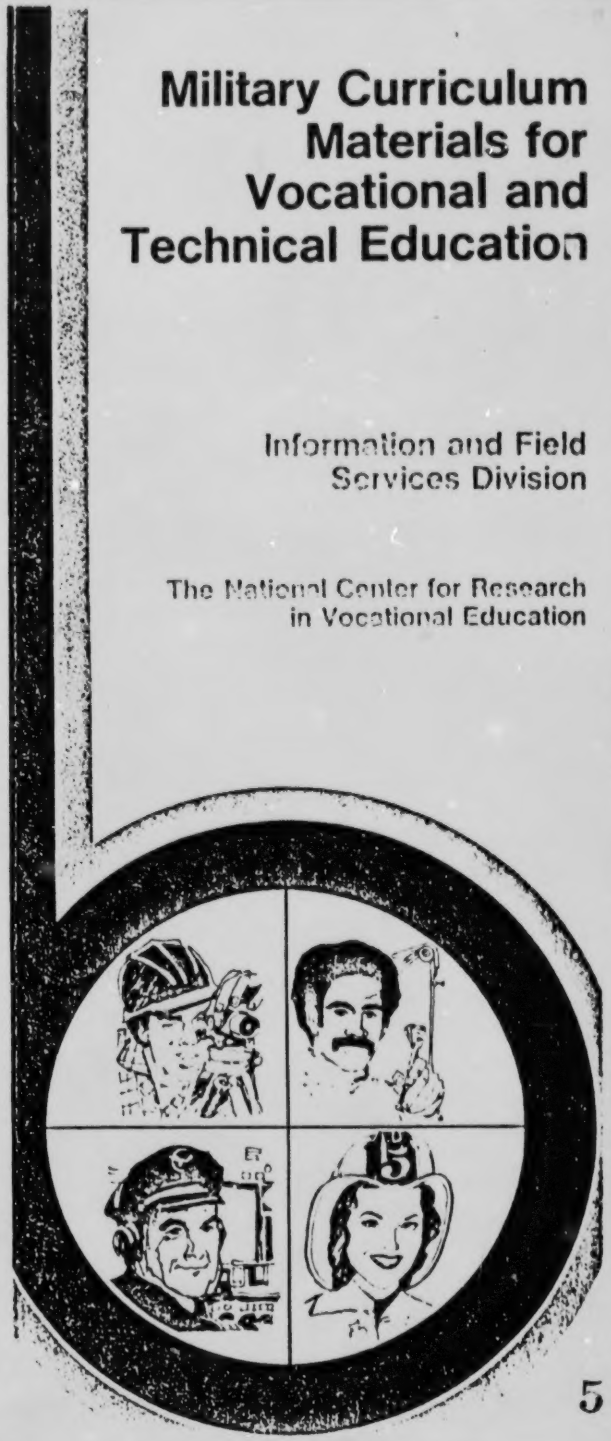
Military Curriculum Materials for Vocational and Technical Education

Information and Field Services Division

The National Center for Research in Vocational Education



Military Curriculum Materials Dissemination Is . . .

an activity to increase the accessibility of military-developed curriculum materials to vocational and technical educators.

This project, funded by the U.S. Office of Education, includes the identification and acquisition of curriculum materials in print form from the Coast Guard, Air Force, Army, Marine Corps and Navy.

Access to military curriculum materials is provided through a "Joint Memorandum of Understanding" between the U.S. Office of Education and the Department of Defense.

The acquired materials are reviewed by staff and subject matter specialists, and courses deemed applicable to vocational and technical education are selected for dissemination.

The National Center for Research in Vocational Education is the U.S. Office of Education's designated representative to acquire the materials and conduct the project activities.

Project Staff:

Wesley E. Budke, Ph.D., Director
National Center Clearinghouse

Shirley A. Chase, Ph.D.
Project Director

What Materials Are Available?

One hundred twenty courses on microfiche (thirteen in paper form) and descriptions of each have been provided to the vocational Curriculum Coordination Centers and other instructional materials agencies for dissemination.

Course materials include programmed instruction, curriculum outlines, instructor guides, student workbooks and technical manuals.

The 120 courses represent the following sixteen vocational subject areas:

- Agriculture
- Aviation
- Building & Construction Trades
- Clerical Occupations
- Communications
- Drafting
- Electronics
- Engine Mechanics
- Food Service
- Health
- Heating & Air Conditioning
- Machine Shop
- Management & Supervision
- Meteorology & Navigation
- Photography
- Public Service

The number of courses and the subject areas represented will expand as additional materials with application to vocational and technical education are identified and selected for dissemination.

How Can These Materials Be Obtained?

Contact the Curriculum Coordination Center in your region for information on obtaining materials (e.g., availability and cost). They will respond to your request directly or refer you to an instructional materials agency closer to you.

CURRICULUM COORDINATION CENTERS

EAST CENTRAL
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100 North First Street
Springfield, IL 62777
217/782-0759

MIDWEST
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1515 West Sixth Ave.
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Mississippi State, MS 39762
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Director
1776 University Ave.
Honolulu, HI 96822
808/948-7834

PETROLEUM SUPPLY SPECIALIST
76W10

Classroom Course 19-4

Developed by:

United States Army

Development and Review Dates:

July 1978

Occupational Area:

Warehousing, Packing and Distribution

Target Audiences:

Grades 11 - Adult

Print Pages:

1019

Availability:

Vocational Curriculum Coordination Centers

Contents:	Type of Materials:						Instructional Design:				Type of Instruction:	
	Lesson Plans:	Programmed Text:	Student Workbook:	Handouts:	Text Materials:	Audio-Visuals:	Performance Objectives:	Tests:	Review Exercises:	Additional Materials Required:	Group Instruction:	Individualized:
Annex A -												
General Petroleum Products	•	•			•	X	•	•	•	•		•
Annex C -												
Class III Supply Point Operations	•	•			•	X	•	•	•	•		•
Annex D -												
Terminal Operations	•	•			•	X	•	•	•	•		•

X Materials are recommended but not provided.

Course Description

This course is designed to provide knowledge in receiving, storing, issuing, dispensing, and shipping of petroleum products. The course consists of three annexes covering 219 hours of instruction.

Annex A - General Petroleum Subjects - provides a knowledge of general subjects required of the Petroleum Supply Specialist:

- Introduction to Course
- Categories of Petroleum Products
- Visual Examination and Contamination of Bulk Petroleum Products
- Petroleum Health and Handling Hazards
- Fire Fighting Equipment and Procedures
- Basic Math Review
- The Army Maintenance Management System (TAMMS)
- Performance Examination
- Operational Maintenance of Instructional Facilities

Annex C - Class III Supply Point Operations - provides a knowledge of methods of petroleum supply, and operation and operator maintenance of petroleum distribution and dispensing equipment used in Class III Supply Points. Subjects covered include:

- Introduction to Supply Point Operations
- Operations of the 50 GPM Pump Operations, Gallon Collapsible Drum, and Filling Cans and Drums
- Operation of the FARE System
- Operation of Tank and Pump Unit
- Rigging for External Helicopter Airlift
- Operation of the 350 GPM Pump and Filter/Separators
- Position Layout and Operation of the Fuel System Supply Point
- Tank Vehicle Operations
- Aircraft Refueling
- Opeational Maintenance of Instructional Facilities

Annex D - Terminal Operations - provides a knowledge in terminal operating principles, procedures, practices, and in operation and operator maintenance of terminal equipment. This includes the following subject materials:

- Aqua Glo Kit
- Introduction
- Gage and Sample Storage Tanks
- Gage Tables and Volume Correction
- Valves, Pipe and Fittings
- Manifolds
- Transfer Pump
- Rail Tank Cars
- Tank Maintenance
- Waterfront Operations
- Practical Exercise and Performance Examination in Terminal Operations
- Operational Maintenance of Instructional Facilities

This section contains both teacher and student materials. Printed instructor materials include a plan of instruction detailing the teaching steps by the units of instruction, criterion objectives, the duration of the lessons, references and instructor's guide for each annex. A course manager's guide has also been included which contains additional references and objectives. Student materials include three study guides with text information, objectives, review exercises, and references. Technical Manual 5-343 and Field Manual 10-69 have been included at the end of the course and it is referred to throughout the course and in the Program of Instruction.

TABLE OF CONTENTS

Volume	Page
Program of Instruction	4
Course Manager's Guide	25
Annex A Instructor Guide	56
Annex A Student Guide	69
Annex C Instructor Guide	224
Annex C Student Guide	241
Annex D Instructor Guide	395
Annex D Student Guide	411
Supplemental Material	727
Petroleum References and Glossary	759
Practical Exercises and Examinations	898
Field Manual 10-69	934
Technical Manual 5-343	1001

NOTE: Annex B has been deleted by the U.S. Army.

DRAFT

U. S. ARMY QUARTERMASTER SCHOOL
FOR LEE, VIRGINIA

JULY 1978

PROGRAM OF INSTRUCTION
FOR

821-76W10
PETROLEUM SUPPLY SPECIALIST

MOS: 76W10

LENGTH: PEACETIME - 8 weeks
MOBILIZATION - 6 weeks, 4 days

THIS DRAFT POI SUPERSEDES POI FOR THE PETROLEUM STORAGE SPECIALIST COURSE, DATED MARCH 19

DRAFT

Section I - Preface

A. Course: 821-76W10, Petroleum Supply Specialist

B. Purpose: To provide enlisted personnel with knowledge in receiving, storing, issuing, dispensing, and shipping of petroleum products. MOS for which trained: Petroleum Supply Specialist (76W10).

C. Prerequisites: Nine months or more of active duty service remaining after completion of course. Standard score of 90 or higher in aptitude area CL. No security clearance required.

D. Length:

Peacetime	Mobilization
8 weeks	7 weeks

E. Training Location: U.S. Army Quartermaster School
Fort Lee, Virginia 23801

F. Mos Feeder Patterns:

Prerequisite MOS	MOS Trained In This Course	Feed Following
09B00	76W10	76W40

G. Ammunition Requirements: No ammunition required.

H. Selected Subjects Recapitulation: Not Applicable.

I. Standardization of Prefix Digit 5 Training: Not applicable.

Section II - Summary

Course - Petroleum Supply Specialist, 821-76W10

Hours - 318

Subject

	Academic Subjects	Hours	Annex	Page
A.				
	General Petroleum Subjects	25	A	7
	* Class III Supply Point Operations	88	C	14
	Terminal Operations	73	D	18
	Military Pipeline Operations	53	E	22
	Subtotal	270		
B.	Nonacademic Subjects			
	Inprocessing	4		
	Physical Conditioning	24		
	Commandant's Time	12		
	Open Time	4		
	Outprocessing	4		
	Subtotal	48		
	Total	318		
C.	Recapitulation			
	1. Unclassified	318		
	Total	318		

2. Types of Instruction

Conference	43.0
Demonstration	5.0
Examination 2	45.8
Practical Exercise 1	134.0
Practical Exercise 2	12.0
Practical Exercise 3	5.3
Film	2.7
Programed Instruction	7.4

	Hours
Television	13.8
Seminar	1.0
Nonacademic	48.0
Total	318.0

* Note: Annex B was deleted by the U.S. Army.

Section III - Body

Course - Petroleum Supply Specialist, 821-76W10

Academic Subjects - Peacetime: 270	Hours	Annex	Page
General Petroleum Subjects		A	7
Introduction to Course	4		7
Categories of Petroleum Products	2		7
Visual Examination and Contamination of Bulk Petroleum Products	5		7
Petroleum Health and Handling Hazards	3		8
Fire Fighting Equipment and Procedures	4		8
Basic Math Review	1		8
The Army Maintenance Management System (TAMMS)	2		9
Performance Examination	2		9
Operational Maintenance of Instructional Facilities	2		10
Annex Total	25		

NOTE: Annex B has been deleted by the U.S. Army.

Section III - Body (Cont)

Annex Title and Subjects	Hours	Annex	Page
Class III Supply Point Operations		C	
Introduction to Supply Point Operations	1		14
Operations of the 50 GPM Pump Operations Gallon Collapsible Drum, and Filling Cans and Drums	14		14
Operation of the FARE System	4		15
Operation of Tank and Pump Unit	8		15
Rigging for External Helicopter Airlift	2		15
Operation of the 350 GPM Pump and Filter/Separators	10		16
Position Layout and Operation of the Fuel System Supply Point	20		16
Tank Vehicle Operations	23		16
Aircraft Refueling	4		17
Operational Maintenance of Instructional Facilities	2		17
Annex Total	88		
Terminal Operations		D	18
Aqua Glo Kit	2		18
Introduction	1		18
Gage and Sample Storage Tanks	14		18
Gage Tables and Volume Correction	5		19
Valves, Pipe and Fittings	6		19
Manifolds	4		19
Transfer Pump	6		20
Rail Tank Cars	7		20
Tank Maintenance	4		20
Waterfront Operations	8		21
Practical Exercise and Performance Examination in Terminal Operations	14		21
Operational Maintenance of Instructional Facilities	2		21
Annex Total	73		

9

Section III - Body (Cont)

Annex Title and Subjects	Hours	Annex	Page
Military Pipeline Operations		E	
Introduction	2		22
Operations of the 4-Stage Pump	7		22
Operations of the 6-Inch Pump	2		22
Pipeline Maintenance	4		23
Pump Station Operation	16		23
Muti-Product Pipelines	3		23
Hoseline Operations	1		24
Practical Exercise and Performance Examination in Pipeline Operations	18		24
Annex Total	53		

MATERIALS NOT AVAILABLE FOR ANNEX E. SEE OTHER PETROLEUM COURSES TO COVER SUBJECT.

Section IV - Annexes

Annex A - General Petroleum Subjects

Purpose - To provide a knowledge of general subjects required of the Petroleum Supply Specialist

File No		Clas	Type of Instruction
PS-A-1-PFS	Introduction to Course		
Hours	4	U	2.7C, 1.3F
Objective:	Describe the duties of Petroleum Supply Specialist MOS 76W10, NCOES prerequisites and promotion potential E-1 thru E-9 in this career field. Flow of petroleum supplies in CONUS and TOPNS. Origin and history of petroleum.		
Reference:	AR 611-201; Sec III FM 100-10 QMS 300.024		FM 29-45, para 5-3, 5-7; F-TFC-32 and Shell Oil Refining DA Pam 611-7 DA Pam 351-48
PS-A-2-PFS	Categories of Petroleum Products		
Hours	2	U	.5C, 1.5PI
Objective:	Identify, list and describe four major categories of petroleum products and give two examples of each category.		
Reference:	FM 10-70		OMS 300.026
PS-A-3-PFS	Visual Examination of Bulk Petroleum Products		
Hours	5	U	.4C, 2.0PE1, 1.6PE2, 1.0E
Objective:	Visually examine bulk petroleum for color and appearance. Recognize five general types of contamination. Identify types and sources of contamination. Describe methods of preventing contamination. Measure the API and group the samples by gravity range.		
Reference:	FM 10-69	QMS 300.656	

Section IV - Annexes (Cont)

File No　　Clas　　Type of Instruction

PS-A-4-PFS　　Petroleum Health and Handling Hazards

Hours　　3　　U　　.2TV　.2C　2.6 PI

Objective:　　Identify fire, safety and health hazards related to petroleum operations. Identify safety precautions in handling petroleum products. Perform necessary first aid for petroleum injuries.

Reference:　　TM 5-637, Para 149-153;
FM 10-69; TV 180 Petrl Safety
(28)　(B/W)　QMS 300.653

PS-A-5-PFS　　Fire Fighting Equipment and Procedures

Hours　　4　　U　　.8TV　.6 D　.4C　2.2 P

Objective:　　Inspect fire fighting equipment common to petroleum units and identify procedures to follow when discrepancies are found. Select the proper fire fighting equipment. Complete fire fighting equipment inspection tags. Apply the principles of extinguishing fires to a given situation.

Reference:　　TM 5-315　　TM 5-687, Para 154-164:
FM 10-69　　MF 10-8814 Oil Fire Protection through knowledge (30)　(C)
GS 10-33, Fire Suppression Equipment Jet X (5.5) (B/W)
MF 20-8778 Stop Them Before They Start (13)　(B/W)
OMS 300.865

PS-A-6-PFS　　Basic Math Review

Hours　　1　　U　　.2C, .8PE3

Objective:　　Solve 70% of the Sample problems correctly.

Reference:　　QMS 15.1PT　　QMS 15.1

12

Section IV - Annexes (Cont)

File No   Clas   Type of Instruction

PS-A-7-PFS   The Army Maintenance Management System (TAMMS)

Hours   2   U   .5TV .4 C1.1PT

Objective: Identify the use and record information on the following forms; DA Form 2400; DA Form 2408-1; DA Form 2404; DA Form 2408-14.

Reference: TM 38-75; VT-T10   QMS 222.3-11

PS-A-8-PFS   Performance Examination

Hours   2   U   2E2

Objective: Perform tasks presented in all previous blocks.

Reference: All previous references.

Section IV - Annexes (Cont)

File No		Clas	Type of Instruction
PS-A-9-PFS	Operational Maintenance of Instructional Facilities		
Hours	2	U	2PE1
Objective:	Perform operational maintenance of instructional equipment and facilities used during this annex.		
Reference:	QMS 222.3-12		
Annex Total	25		

NOTE: ANNEX B HAS BEEN OMITTED BY THE U.S. ARMY.

Section IV - Annexes (Cont)

Annex C - Class III Supply Point Operations

Purpose - To provide a knowledge of methods of petroleum supply in the combat zone, and operation and operator maintenance of petroleum distribution and dispensing equipment used in Class III Supply Points

File No	Clas	Type of Instruction
PS-C-1-PFS	Introduction to Supply Point Operations	
Hours	1	U 1C
Objective:	Identify subject areas contained in the " C " Annex.	
Reference:	FM 10-69	QMS 300.719
PS-C-2-PFS	Operations of the 50 GPM Pump, 500 Gallon Collapsible Drum, Filling of 5, 55 and 500 Gallon Drums	
Hours	14	U 1TV .2 C 4E2 8.8 PE1
Objective:	Perform operators maintenance on the 50 GPM pump and organic equipment, fill the 500-gallon collapsible drum using the 50 GPM pump and organic equipment, fill the 500-gallon collapsible drum using the 50 GPM pump and automatic pressure control valve, fill 5-gallon cans and 55-gallon drums using the 50 GPM pump and hose fitting kit and operate the 50 GPM pump in any directed operations.	
Reference:	FM 10-69; VT FM 10-69; VT 407; para 19 and 20; TM 10-4320-202-15; Para 9,10,13,46-62; VT 131 Operation of the 50 GPM Petroleum Dispenser (26.10)(3 TF 10-3868 Care and Use of the Collapsible Drums (23) (B/W) QMS 300.432	

Section IV - Annexes (Cont)

File No	Clas		Type of Instruction
PS-C-3-PFS	Operation of the FARE System		
Hours	4	U	.2 C 3.8 PE1

Objective: Set up FARE system exercising all safety precautions. Perform operator maintenance check on pump and ralated hose assembly. Operate the FARE system in aircraft refueling operations.

Reference: TM 5-4320-248-15, FM 10-68
DTM 5-4930-211-14 QMS 300.664

File No	Clas		Type of Instruction
PS-C-4-PFS	Operation of Tank and Pump Unit		
Hours	8	U	.4C .6TV 2E2 5PE1

Objective: Convert the common cargo truck to a 1200 gallon tank vehicle. Fill 55-gallon drums and/or 5-gallon cans. Fill 500-gallon collapsible drums. Refuel vehicles and/or aircraft.

Reference: TM 10-4930-204-15; Chap 1-3;
VT-177 POL TankVehicle Operations (Tank and Pump Unit)
(30) (B/W) QMS 300.596-1

File No	Clas		Type of Instruction
PS-C-5-PFS	Rigging for External Helicopter Airlift		
Hours	2	U	.4C, 1PE1, 6TV

Objective: Rig and hook up packaged petroleum using the sling assembly. Rig a sling hook-up for 500-gallon collapsible drums. Demonstrate the proper use of the static electricity discharge probe.

Reference: TM 10-500 TM 10-500-39
TM 55-450-8 TF-55-3839 Sling Loading of Helicopter
QMS 78.23-4 (30) (B/W)

Section IV - Annexes (Cont)

File No. Clas Type of Instruction

PS-C-6-PFS Operation of the 350 GPM Pump and Filter/Separators

Hours: 10 U .3C, 7.7PE1, 2E

Objective: Perform operational safety check and maintenance. Operate 350 GPM pump, making adjustments in given operations. Operate the 350 GPM filter/separator, checking pressure and recording reading in log book.

Reference: TM 5-4320-200-15, TM 5-4320-218-15, RF 2217/3 Role of the Filter Separator in National Defense (17) (c), VT-130 Operations of the 350 GPM Petroleum Dispenser (29.35) (B/W), QMS 300.663

PS-C-7-PFS Position, Layout and Operation of the Fuel System Supply Point

Hours: 20 U .7C, 4.5PE1, 12E2, 2.8TV

Objective: Identify and layout all the component parts of the fuel system supply point in the proper position, connect the manifold assembly to the 10,000 gallon collapsible storage tank, operate the fuel system supply point, perform operator maintenance, comply with safety procedures and secure the fuel system supply point.

Reference: TB 5-4930-201, FM 21-41, FM 21-48, VT 176, TF 3-3753, TF 3-4471, TF 3-3966, TF 3-4269, QMS 300.666

PS-C-8-PFS Tank Vehicle Operations

Hours: 23 U .4C, 1.9E, 1TV, 19.7PE1

Objective: Perform operators maintenance on the components of tank vehicles and record all action on DA Form 2404. Operated the auxillary pumps in transferring products, observing safety precautions. Perform on-loading and off-loading operations of both types of tank vehicles as directed.

Reference: TM 9-2320-209-10, Chap II, Sec VII, TM 9-2330-272-14, FM 10-71, VT-124 Tank Truck (Filter Separator) (16) (B/W), TF 10-4319, QMS 300.439

Section IV - Annexes (Cont)

File No	Clas	Type of Instruction

PS-C-9-PFS Aircraft Refueling

Hours	4	U	2PE1	1.9E	.1C

Objective: Refuel and/or defuel aircraft with army tank vehicles. M49C services,1200 gal. 2 1/2 ton, and M131C services, 5000 gal semitrailer 5 ton. Refuel aircraft using the (Fares) Forward Area Refueling Equipment System. Perform rapid refueling of helicopters using the ten point procedures. Use all safety measures that are required in aircraft refueling operations.

Reference: FM 10-68, TB 55-9150-200-25; Sec 2
QMS 300. 304-1

PS-C-10-PFS Operational Maintenance of Instructional Facilities

Hours	2	U	2PE1

Objective: Maintain TOE and Petroleum Handling Equipment. Assist in performing preventive maintenance.

Reference: All previous references
QMS 222.3-14

Annex Total 88

Section IV - Annexes (Cont)

Annex D - Terminal Operations

Purpose - To provide a knowledge in terminal operating principles, procedures, practices, and in operation and operator maintenance of terminal equipment

File No   Clas   Type of Instruction

PS-D-1-PFS   Introduction

Hours   1   U   1C

Objective: Identify the subject areas that are contained in the "D" annex (Terminal Operations).

Reference: FM 10-18,   QMS 300.501

PS-D-2-PFS   Aqua-Glo Water Detection Test

Hours   2   .7C   .1TV   .2D   1PE1

Objective: Take a fuel sample without spilling or contaminating it. Conduct an Aqua-Glo test on that sample accurate to within 5 parts per million of water.

Reference: FM 10-68, FM 10-70,   QMS 300.506

PS D-3-PFS   Gage and Sample Storage Tanks

Hours   14   U   1TV   .4C   4 PE3   8.6 PE1

Objective: 1. Take a bottom sample from a bulk storage tank using the step by step procedures; fill out a sample tag; identify and perform different sampling methods and techniques; take a multitank sample from a tank farm complex; take an all level sample.

2. Measure the bottom sediment and water (BS&W) in a storage tank; subtract the measured volume of BS&W from the volume of petroleum; record the average temperature of petroleum in a storage tank and observe all safety precautions and procedures.

Reference: TM 10-1101; VT-133 Sampling Bulk Petroleum (19.25) (B/W)
VT-132 Measuring Bulk Petroleum (27.30) (B/W) QMS 300.503
FM 10-18, ATSM Method D-270.

Section IV - Annexes (Cont)

File No   Clas   Type of Instruction

PS-D-4-PFS   Gage Tables and Volume Correction

Hours   5   U   3.7 PE2 .3C 1E2

Objective: Determine the volume of measured liquid petroleum using the strapping table. Determine the correction factor for each product listed in the volume tables, when given the observed temperature. Correct the measured volume to sixty (60) degrees fahrenheit. Determine what group number a given API gravity range is in by corresponding degree of API gravity using table III.

Reference: FM 10-18; FM 10-68, Table 8, Para 95; QMS 300.505

PS-D-5-PFS   Valves, Pipes and Fittings

Hours   6   U   1.6C, 4PE1, .4TV

Objective: Identify the different types of valves and fittings, Perform inspections and operator maintenance on the valves. Identify the use and purpose of each fitting used in Petroleum Pipeline Operations. Identify the use and purpose of each valve used in Petroleum Pipeline Operations.

Reference:
TM 5-343 para 3-4;
FM 10-20 para 5-30;
TM 5-678 para 16;   TF 10-3702 Valves in Pipeline
QMS 300.502   (18) (B/W)

PS-D-6-PFS   Manifolds

Hous   4   U   1C, 2PE2, 1PE1

Objective: Identify the different types and purposes of manifolds used in bulk petroleum operations. Identify pipelines by standard marking codes. Perform operation maintenance on the manifold.

Reference:
TM 5-345 Chap 10; Sec IV; FM 10-18
MIL-STD 161D   QMS 300.507

Section IV - Annexes (Cont)

File No	Clas		Type of Instruction
PS-D-7-PFS	Transfer Pump		
Hours	6	U	1C, .5D, 4.5 PE1

Objective: Perform operator maintenance and fill out Form 2404 on a single stage pump unit. Operate the pump unit in accordance with given situations. Perform all safety precaution checks. Record all pumping orders in the terminal log book.

Reference: TM 5-4320-211-12, para 10;
FM 10-18
QMS 300.508

File No	Clas		Type of Instruction
PS-D-8-PFS	Load Rail Tank Cars		
Hours	7	U	2C, 5PE1

Objective: Position the tank car, ground and bond, observing all safety precautions. Inspect the tank car, sample residue innage and service for which intended. Identify two methods of loading and unloading a rail tank car. Load the tank car and gage with both the long pole and short pole methods. Take a sample and temperature of the product after loading the tank car.

Reference: TM 10-1101; para 91-95;
FM 10-18; Chap V; QMS 300.511

File No	Clas		Type of Instruction
PS-D-9-PFS	Tank Maintenance		
Hours	4	U	3C, .5D, .5PE1

Objective: Fit the safety harness of the mine safety set to his body. Fit the fresh air mask of the mine safety set to his face. Identify the uses of the explosimeter indetecting flammable vapors. Operate the explosimeter in inspecting a hazardous area. Perform external maintenance on petroleum storage tanks and accessories.

Reference: AR 420-56
TM 5-678; para 13,14,15,
FM 10-20
QMS 300.510

Section IV - Annexes (Cont)

File No	Clas	Type of Instruction	
PS-D-10-PFS	Waterfront Operations		
Hours	8	U	2.3C, 4PE1, 1PE2, .7TV

Objective: Connect bonding from shore to ship and close the grounding switch. Board the ship and gage, sample all cargo tanks, before and after readings. Couple cargo hose from shore to ship and make preoperational checks to prevent oil spills. Discharge cargo from ship to base terminal. Unload the ship using shore base facilities. Fill out tanker discharge report form DD 250-1. Issue a dry tank certificate. Name three ways to clean up oil spills.

Reference:
TF 10-2855, POL Pier Operations
FM 10-18; Chap II;
MF 7790 Measuring and Sampling Barges, Tankers (16) (B/W)
QMS 300.512

PS-D-11-PFS Practical Exercise and Performance Examination in Terminal Operations

Hours	14	U	.2C 5.8PE1, 8E2

Objective: The student will perform in each area and be graded on waterfront, tank car, gaging and sampling phase of the operations.

Reference:
All previous references
QMS 300.513

PS-D-12-PFS Operational Maintenance of Instructional Facilities

Hours	2	U	2PE1

Objective: Maintain TOE and Petroleum Handling Equipment. Assist in performing preventive maintenance.

Reference:
All previous reference
QMS 222.3-15

Annex Total 73

22

Section IV - Annexes (Cont)

Annex E - Military Pipeline Operations MATERIALS NOT AVAILABLE. SEE OTHER PETROLEUM COURSES.

Purpose - To provide knowledge of military pipeline operations, practices, and procedures, and the operation and maintenance of pipeline equipment.

File No	Clas		Type of Instruction
PS-E-1-PFS	Introduction		
Hours	2	U	1.5C, .5TV

Objective: Identify the contents of "E" Annex. Identify the advantages and disadvantages of Military Pipeline.

Reference: TM 5-345; FM 10-18
HRE-7 Military Pipelines System CBI Theatre (23) (B/W)
QMS 300.401

File No	Clas		Type of Instruction
PS-E-2-PFS	Operation of the 4-inch, 4-stage Pump		
Hours	7	U	.2C, .5D, 4.5PEP1

Objective: Perform operator maintenance. Prepare DA Form 2404 and 2408-1. Operate the four-inch, four-stage pumping unit. Identify safety checks required in all pumping operations. Identify the proper suction and discharge pressure for normal pumping operations.

Reference: TM 5-4320-210-12; TM 38-750; Chap 2 and 3
QMS 300.402

File No	Clas		Type of Instruction
PS-E-3-PFS	Operation of the 6-inch, 2-stage Pump		
Hours	2	U	.7C, .3D, 1PE1

Objective: Perform preoperational maintenance and safety check. Identify the difference between series and parallel connection. Operate the six-inch, two-stage pumping unit. Identify procedures for setting safety control switch.

Reference: TM 5-9427; TM 5-4320-217-15; Chap 1,2,3;
FM 10-20; FM 10-13; QMS 300.404

Section IV - Annexes (Cont)

File No	Clas		Type of Instruction
PS-E-7-PFS	Hoseline Operations		
Hours	1	U	1TV

Objective: Identify the assault hoseline. Identify the intended use.

Reference: FM 5-343; para 9-19; 9-25
VT-128, The 4" Petroleum Assault Hoseline
QMS 300.407

PS-E-8-PFS	Practical Exercise and Performance Examination in Pipeline Operations		
Hours	18	U	8PE1, 10E

Objective: Work through a practical exercise on all phases of pipeline operations and then be given a graded performance examination.

Reference: All previous references
QMS 300.481

Annex Total 53

Section IV - Annexes (Cont)

File No	Clas		Type of Instruction
PS-E-4-PFS	Pipeline Maintenance		
Hours	4	U	1.4C, .5D, 1.5PE1 .2PE2, .4TV

Objective: Identify four methods of repairing coupled pipeline leaks. Fill out a leak report DA Form 10242. Locate leaks in a pipeline by patrolling. Identify different methods of patrolling.

Reference:
AR 420-56; FM 10-20; para 7,13,17,20;
TF 5-1862 Military Pipeline Operations
Part I Laying Pipelines
QMS 300.405

File No	Clas		Type of Instruction
PS-E-5-PFS	Pump Station Operations		
Hours	16	U	1.3C, 5PE2, .5D, 13.5PE1, .2TV

Objective: Perform inspection and prepare station for receipt of pumping order. Put pumping station on line when proper suction pressure is observed and in the correct sequence. Rotate pumping units and perform operator maintenance. Identify and execute all pumping orders. Conduct scraper operations as required.

Reference:
FM 10-20
FM 10-18
Scrapers and Sandtraps
QMS 300.403

File No	Clas		Type of Instruction
PS-E-6-PFS	Operate Multi-Product Pipelines		
Hours	3	U	2C, 1D

Objective: Identify the proper sequence for batching a mult-product pipeline. Detect an interface by API gravity. Identify methods to dispose of interface with waste. Record time of color and gravity change. Identify proper gravity cut for interface.

Reference:
FM 10-69
FM 10-18
QMS 300.406

25

NIPUB 358(CMG)C

COURSE MANAGER'S GUIDE

PETROLEUM SUPPLY SPECIALIST
MOS 76W10

U.S. ARMY QUARTERMASTER SCHOOL
FORT LEE, VIRGINIA

SUPPLY TRAINING CENTER OF THE ARMY SCHOOL SYSTEM

ATSM-TNG-TM-ET

MAY 1978

Army-Fort Lee, Va.-4100-75-100-1

32

26

TABLE OF CONTENTS

		Paragraph	Page
Section I	INTRODUCTION		
	Purpose	1	1
	Materials	2	1
	Reproduction of Materials	3	1
	Background	4	1
	Recommended Changes	5	1
	Course Map	6	1
	Method of Instruction	7	2
Section II	COURSE COMPOSITION		
	Prerequisite	8	2
	Annex Composition	9	2
	Testing	10	3
	Student Records	11	4
	Special Notice	12	4
Annex C	Course of Instruction	C-1 - C-16	
Annex D	Course Material MOS 76W10	D-1	
Annex E	Equipment	E-1 - E-2	

NOTE: A-1, Course Map, has been deleted because of military specific materials. Annex B has been deleted by the U.S. Army.

COURSE MANAGEMENT GUIDE

MOS 76W10, Petroleum Supply Specialist

Section I. Introduction

1. PURPOSE. This guide has been developed to help commanders and course managers implement the training and evaluation program for MOS 76W10 (skill level 1 under the Enlisted Personnel Management System (EPMS)). It indicates how the course is to be constructed, how the students will be trained, what they must be taught, when they will be tested, and how they will be evaluated. However, this document is not intended to provide all of the management guidance for the course. Commanders and course managers may change, revise, or deviate from this guide as local SOP's and mission requirements dictate.

2. MATERIALS. Each annex is accompanied by a Student Guide and Instructor Guide. These guides are fundamental and integral parts of the entire training package for this course. As the course manager is responsible for overall conduct of training, it is necessary for you to be familiar with how the course works. For this reason you should read and maintain a copy of all course materials to include appropriate guides.

3. REPRODUCTION OF MATERIALS. Instructional materials have been provided in reproducible form. You will need one copy per student of all materials shown on the materials checklist, except for the annex examinations; you will need two copies per student for each exam. In situations where a DD or DA Form is required, you should provide at least three copies of the form to each student.

4. BACKGROUND. As the course manager, it is not necessary for you to be an expert in the subject matter MOS. However, it is recommended that you familiarize yourself with the method of instruction used for this course (see paragraph 7). Materials and logistical requirements are listed in the Instructor and Student Guides of each annex.

5. RECOMMENDED CHANGES. You are encouraged to recommend changes or modifications to the course. Your comments and suggestions should be sent to Commandant, U. S. Army Quartermaster School, ATTN: ATSM-TD-CD-IMD, Fort Lee, Virginia 23801.

Note: Number 6 has been omitted because
of military Specific Materials.

7. METHODS OF INSTRUCTION. Instructional materials for the course are self-paced; that is, the students study and progress at a pace which is best suited to their mental and physical capabilities. Therefore, students do not compete with each other, but with themselves as they progress through the course. The time allotted for coverage of each instruction block is indicated in the Instructor and Student Guides. The time frames are suggested allotments. You are free to increase or decrease the time element if circumstances warrant such action. The following are two types of settings that will be used for teaching MOS 76W10.

a. Classroom. The classroom is used for those instruction blocks that do not require any special equipment or materiel. This type of setting has the advantage of providing the student with a quiet atmosphere in which to work and study. The classroom setting also provides quick access to reference materials and the instructor in situations where students need immediate feedback to their problems or questions.

b. Petroleum Training Facility (PTF). While the students are in training for MOS 76W10, a great deal of time will be spent at an actual or simulated petroleum training facility (PTF). The PTF should be equipped with those items of equipment listed in the Instructor and Student Guides. In addition, the PTF should provide suitable study and relaxation areas since the majority of training and evaluation of students enrolled in 76W10 will be conducted in this type of setting.

Section II. Course Composition

8. PREREQUISITE. Students enrolled in this course should be able to read, to write legibly, and to do basic arithmetic. The instructional materials for this course are written at about a 10th grade readability level (based on the FORCAST readability formula). Instructors should make a sincere effort to identify those students with reading handicaps and adjust their schedules to accommodate these students.

9. ANNEX COMPOSITION. The entire course is divided into three annexes, each of which is broken down into several instructional blocks (see para 6). Each student is provided with his/her Student Guide and the instructional materials required for each block, such as programed texts (PT's), practical exercises (PE's), and handouts. Instructors should be provided with an Instructor Guide, a Student Guide, and a copy of each item of material used by the students.

The Instructor and Student Guides outline for the instructor and the student, respectively, the course content and objectives of each instruction block as well as the logistical requirements. In some instances, local conditions and operating procedures or mission requirements may necessitate some alterations or revisions to these guides.

10. TESTING. Testing for MOS 76W10 is usually covered in the last instruction block of the annex. Because of the nature in which some of the instructional materials are developed, students will be tested after completing instruction block D-3 and upon completion of all blocks in Annex D. However, there is no examination given after completion of Annex C; instead, students are tested only on certain blocks as they progress through the annex. During testing, students are permitted to refer to any reference materials used in the annex.

a. Standard. Students who successfully complete the annex examination with 70 percent or higher of the raw score are permitted to advance to the next course annex.

b. Pretesting. This course does not provide any materials for pretesting students. However, remind students that they are free to skip or pass a block of instruction if the material covers a subject area in which they are already familiar or feel qualified to handle without further study. At the same time, the students must be cautioned that they will not be able to demonstrate their confidence until they are ready to take the annex examination.

c. Retesting. Any student scoring less than 70 percent of the raw score on an annex examination must take a retest at a time and place designated by the instructor, commander, or course manager. Only on special occasions are students permitted to take a second retest if they fail the first one. A second retest is granted only at the sanction or approval of the commander or course manager if recommended by the instructor. If a student fails to pass the first or second retest, it is customary to have the student dropped from the course and reassigned elsewhere or reclassified to another MOS.

d. Critiquing test. Under self-paced instruction, the instructor must critique or review all areas of the annex examination with the student. This gives the instructor an opportunity to counsel and assist those students who might have learning problems with the materials.

e. Security procedures. It is imperative that all examination material and solution sheets be secured at all times under lock and key when not in use. These materials should be released only to the instructor. After a student has completed an examination, the instructor should grade it immediately, critique it with the student, and have the copy filed securely or destroyed. If an examination is compromised in any way by the instructor or course manager, it will be incumbent upon the instructor or course manager to revise or prepare a new examination.

11. STUDENT RECORDS. An academic record is prepared and maintained on each student as he/she progresses through the course. The instructor is responsible for recording and maintaining the data reflected on this record. The commander or course manager should prepare a guideline for instructors specifying the types of academic data that will be kept on each student. Additional information on preparation and maintenance of student files is contained in the Instructor Guide.

12. SPECIAL NOTICE: Please note that no material is provided for Annex "B", Package Operation and Annex "E", Pipeline Operations for the Course of Instruction outlined in Annex C to this publication. You will also note that several Quartermaster Subcourses have been identified for each of these annexes that are recommended as a means to partially accomplish these training requirements. Enrollment in these subcourses can be accomplished by completing a DA Form 145, Application for Enrollment, and submit to the Army Correspondence Course Program (ACCP), US Army Training Support Center, Newport News, VA 23628. The best means to accomplish this training is at Fort Lee, VA or during the units AT where facilities are available.

REFERENCES
76W10

ANNEX A

FM 29-45	Jun 65	General Support Supply and Service in the Field Army
FM 100-10	Apr 76	Combat Service Support
TM 5-315	Apr 71	Firefighting and Rescue Procedures in Theaters of Operations
TM 5-687	Dec 57	Repair and Utilities; Fire Protection Equipment and Appliances; Inspections and Operations
TM 10-1101	May 72	Petroleum Handling Equipment and Operations
TM 10-1105	Jan 72	Inspecting and Testing Petroleum Products
TM 10-1166	May 73	1972 Book of ASTM Standards
TM 38-750	Nov 72	The Army Maintenance Management System (TAMMS)

ANNEX C

FM 21-41	Feb 67	Soldiers Handbook for Defense Against Chemical and Biological Operations and Nuclear Warfare
FM 21-48	Jun 73	Planning and Conducting Chemical, Biological, Radiological (CBR) and Nuclear Defense Training
TM 5-4320-200-15	Nov 68	Operators, Organizational, Direct Support, General Support and Depot Maintenance of Centrifugal Pump
TM 5-4320-218-15	Mar 61	Operators, Organizational, Direct Support, General Support and Depot Maintenance Manual 350 GPM Pump
TM 9-2330-274-14	Jun 72	Operators, Organizational, Direct Support and General Support Maintenance Manual for Semitrailer Tank 5000 gal M131A4C, M131A5C
TM 10-500	Jan 72	Airdrop of Supplies and Equipment: General Information for Rigging Airdrop Platforms
TM 10-1113	Jun 69	Petroleum Tank Vehicle Operation
TM 10-4320-202-15	May 68	Operator, Organizational, Direct Support and General Support Maintenance Manual 50 GPM Pump
TM 10-4930-203-13	May 65	Operator, Organizational and Direct Support Maintenance Manual Fuel System Supply Point
TM 10-4930-204-15	Sep 67	Operator, Organizational, Direct Support, General Support and Depot Maintenance Manual - Tank and Pump Unit

TM 5-4320-248-15	Oct 67	Operator, Organizational, Direct Support, General Support and Depot Maintenance Manual; 100 GPM Pump

ANNEX D

FM 10-18	Apr 74	Petroleum Terminal and Pipeline Operations
TM 5-343	Feb 69	Military Petroleum Pipeline Systems
TM 5-4320-211-12	Jan 61	Operator and Organizational Maintenance Manual Centrifugal Pump
TM 10-1112	Oct 64	Military Petroleum Pipeline Systems: Scheduling and Dispatching
TM 10-1118	Sep 66	Petroleum Terminal and Pipeline Operations
FM 10-20	May 74	Organizational Maintenance — Military Petroleum Pipeline Tanks and Related Equipment

ANNEX C COURSE OF INSTRUCTION

A. Course: 821-76W10, Petroleum Supply Specialist

B. Purpose: To provide enlisted personnel with knowledge in receiving, storing, issuing, dispensing, and shipping of petroleum products. MOS for which trained: Petroleum Supply Specialist (76W10).

C. Prerequisites: Standard score of 90 or higher in aptitude area CL. No security clearance required.

Annex A - General Petroleum Subjects

Purpose - To provide a knowledge of general subjects required of the Petroleum Supply Specialist

File No		Clas	Type of Instruction
A-1	Introduction to Course		
Hours	4	U	2.7C, 1.3F
Objective:	Describe the duties of Petroleum Supply Specialist MOS 76W10, NCOES prerequisites and promotion potential E-1 thru E-9 in this career field. Flow of petroleum supplies in CONUS and TOPNS. Origin and history of petroleum.		
Reference:	AR 611-201; Sec III, FM 29-45, Para 5-3, 5-7; FM 100-10 F-TFC-32 and Shell Oil Refining QMS 300.024 DA Pam 611-17 DA Pam 351-48		
A-2	Categories of Petroleum Products		
Hours	2	U	.5C, 1.5PI
Objective:	Identify, list and describe four major categories of petroleum products and give tow examples of each category.		
Reference:	TM 10-1105 QMS 300.026		
A-3	Visual Examination of Bulk Petroleum Products		
Hours	5	U	.4C 2.0PE1 1.6PE2 1.0E
Objective:	Visually examine bulk petroleum for color and appearance. Recognize five general types of contamination. Identify types and sources of contamination. Describe methods of preventing contamination. Measure the API and group the samples by gravity range.		
References:	TM 10-1101 TM 10-1166 QMS 300.656		

File No		Clas	Type of Instruction
A-4	Petroleum Health and Handling Hazards		
Hours	3	U	.2TV, .2C, 2.5PI
Objective	Identify fire, safety and health hazards related to petroleum operations. Identify safety precautions in handling petroleum products. Perform necessary first aid for petroleum injuries.		
References:	TM 5-687, Para 149-153; TM 10-1101; TV 180 Petrl Safety (28) (B/W) QMS 300.653		
A-5	Fire Fighting Equipment and Procedures		
Hours	4	U	.8TV, .6D, .4C, 2.2PI
Objective:	Inspect fire fighting equipment common to petroleum units and identify procedures to follow when discrepancies are found. Select the proper fire fighting equipment. Complete fire fighting equipment inspection tags. Apply the principles of extinguishing fires to a given situation.		
References:	TM 5-315, TM 10-1101, TM 5-687, Para 154-164; MF 10-8814 Oil Fire Protection through knowledge (30) (C) GS 10-33, Fire Suppression Equipment Jet X (5.5) (B/W) MF 20-8778 Stop Them Before They Start (15) B/W) QMS 300.865		
A-6	The Army Maintenance Management System (TAMMS)		
Hours	2	U	.5TV, .4C, 1.1PI
Objective:	Identify the use and record information on the following forms; DA Form 2400; DA Form 2408-1; DA Form 2404; DA Form 2408-14.		
References:	TM 38-750; VT-T10, QMS 222.3-11		
Annex Total	20		

Annex C - Class III Supply Point Operations

Purpose - To provide a knowledge of methods of petroleum supply in the combat zone, and operation and operator maintenance of petroleum distribution and dispensing equipment used in Class III Supply Points

File No		Clas	Type of Instruction
C-1	Introduction to Supply Point Operations		
Hours	1	U	1C
Objective:	Identify subject areas contained in the "C" Annex.		
References:	TM 10-1101, QMS 300.719		
C-2	Operations of the 50 GPM Pump, 500 Gallon Collapsible Drum, Filling of 5, 55, and 500 Gallon Drums		
Hours	14	U	1TV, .2C, 4E2, 8.8PE1
Objective:	Perform operators maintenance on the 50 GPM pump and organic equipment, fill the 500-gallon collapsible drum using the 50 GPM pump and organic equipment, fill the 500-gallon collapsible drum using the 50 GPM pump and automatic pressure control valve, fill 5-gallon cans and 55-gallon drums using the 50 GPM pump and hose fitting kit and operate the 50 GPM pump in any directed operation.		
References:	TM 10-1101 VT 407; Para 19 & 20; TM 10-4320-202-15; Para 9, 10, 13, 46-62; VT 131 Operation of the 50 GPM Petroleum Dispenser (26.10)(B/W) TF 10-3868 Care and Use of the Collapsible Drums (23) (B/W)		
C-3	Operation of the FARE System		
Hours	4	U	.2C 8.8 PE1
Objective:	Set up FARE system exercising all safety precautions. Perform operator maintenance check on pump and related hose assembly. Operate the FARE system in aircraft refueling operations.		

File No		Clas	Type of Instruction
References:	TM 5-4320-248-15, DTM 5-4930-211-14, QMS 300.664		
C-4	Operation of Tank and Pump Unit		
Hours	8	U	.4C, .6TV, 2E, 5PE1
Objective:	Convert the common cargo truck to a 1200 gallon tank vehicle. Fill 55-gallon drums and/or 5-gallon cans. Fill 500-gallon collapsible drums. Refuel vehicles and/or aircraft.		
References:	TM 10-4930-204-15; Chap 1-3; VT-177 POL Tank Vehicle Operation (Tank and Pump Unit) (30) (B/W), QMS 300.596-1		
C-6	Operation of the 350 GPM Pump and Filter/Separators		
Hours	10	U	.3C, 9.7PE1
Objective:	Perform operational safety check and maintenance. Operate the 350 GPM pump, making adjustments in given operations. Operate the 350 GPM filter/separater, checking pressure and recording reading in log book.		
References:	TM 5-4320-200-15, TM 5-4320-218-15 RF 2217/3 Role of the Filter Separator in National Defense (17) (C) VT-130 Operation of the 350 GPM Petroleum Dispenser (29.35) (B/W), QMS 300.663		
C-7	Position, Layout and Operation of the Fuel System Supply Point		
Hours	20	U	.7C, 4.5PE1, 12E, 2.8TV
Objective:	Identify and layout all the component parts of the fuel system supply point in their proper position, connect the manifold assembly to the 10,000 gallon collapsible storage tank, operate the fuel system supply point, perform operator maintenance, comply with safety procedures and secure the fuel system supply point.		
References:	TM 10-4930-203-13; FM 21-41; FM 21-48; VT 176; TF 3-3753; TM 3-4471; TF 3-3966; TF 3-4269, QMS 300.656		

File No		Clas	Type of Instruction
C-8	Tank Vehicle Operations		
Hours	20	U	.4C, 1.9E, 1TV, 19.7PE1

Objective: Perform operator maintenance on the components of tank vehicles and record all action on DA Form 2404. Operate the auxillary pumps in transferring products, observing safety precautions. Perform on-loading and off-loading operations of both types of tank vehicles as directed.

References: TM 9-2320-209-10; Chap II, Sec VII; TM 9-2330-272-14; TM 10-1113; VT-124 Tank Truck (Filter Separator)(16) B/W TF-10-4319, QMS 300.439

Annex Total 77

Annex D - Terminal Operations

Purpose - To provide a knowledge in terminal operating principles, procedures, practices, and in operation and operator maintenance of terminal equipment

File No		Clas	Type of Instruction
D-3	Gage and Sample Storage Tanks		
Hours	14	U	1TV, .4C, 4PE3, 8.6PE1

Objective: 1. Take a bottom sample from a bulk storage tank using the step by step procedures; fill out a sample tag; identify and perform different sampling methods and techniques; take a multitank sample from a tank farm complex; take an all level sample.

2. Measure the bottom sediment and water (BS&W) in a storage tank; subtract the measured volume of BS&W from the volume of petroleum; record the average temperature of petroleum in a storage tank and observe all safety precautions and procedures.

References: TM 10-1101; VT-133 Sampling Bulk Petroleum (19.25) (B/W)
VT-132 Measuring Bulk Petroleum (27.30) (B/W) QMS 300.503

File No		Clas	Type of Instruction
D-4	Net Innage and Volume Correction		
Hours	5	U	3.7 PE2, .3C 1 E

Objective: Determine the volume of measured liquid petroleum using the strapping table. Determine the correction factor for each product listed in the volume tables, when given the observed temperature. Correct the measured volume to sixty (60) degrees fahrenheit. Determine what group number a given API gravity range is in by corresponding degree of API gravity using table III.

References: TM 10-1101 Table 8, Para 95; QMS 300.505

File No Clas Type of Instruction

D-5 Valves, Pipes and Fittings

Hours 6 U 1.6C, 4PE1, .4TV

Objective: Identify the differenc types of valves and fittings, Perform inspections and operator maintenance on the valves. Identify the use and purpose of each fitting used in Petroleum Pipeline Operations. Identify the use and purpose of each valve used in Petroleum Pipeline Operations.

References: TM 5-343 Para 3-4; TM 10-1109, Para 5-30; TM 5-678, Para 16; TF 10-3702 Valves in Pipeline, QMS 300.502 (18) (B/W)

D-6 Manifolds

Hours 4 U 1C, 2PE2, 1PE1

Objective: Identify the different types and purposes of manifolds used in bulk petroleum operations. Identify pipelines by standard marking codes. Perform operation maintenance on the manifold.

References: TM 5-343, Chap 10; Sec IV; TM 10-118; MIL-STD 161D, QMS 300.507

D-7 Transfer Pump

Hours 6 U 1C, .5D, 4.5PE1

Objective: Perform operator maintenance and fill out form 2404 on a single stage pump unit. Operate the pump unit in accordance with given situations. Perform all safety precaution checks. Record all pumping orders in the terminal log book.

References: TM 5-4320-211-12, para 10; TM 10-1112, para 16, 17; TM 10-1118; QMS 300.508

D-8 Load Rail Tank Cars

Hours 7 U 2C, 5PE1

Objective: Position the tank car, ground and bond, observing all safety precautions. Inspect the tank car, sample residue innage and service for which intended. Identify two methods of loading and unloading a rail tank car. Load the tank car and gage with both the long pole and short pole methods. Take a sample and temperature of the product after loading the tank car.

File No		Clas	Type of Instruction
References:	TM 10-1101; Para 91-95; TM 10-1118; Chap V; QMS 300.511		
D-9	Tank Maintenance		
Hours	4	U	3C, .5D, .5PE1
Objective:	Fit the safety harness of the mine safety set to his body. Fit the fresh air mask of the mine safety set to his face. Identify the uses of the explosimeter in detecting flammable vapors. Operate the explosimeter in inspecting a hazardous area. Perform external maintenance on petroleum storage tanks and accessories.		
References:	AR 420-56; TM 5-678, Para 13, 14, 15; TM 10-1109, Para 79-84; QMS 300.510		
D-10	Waterfront Operations (O~~ptional~~)		
Hours	8	U	2.3C, 4PE1, 1PE2, .7TV
Objective:	Connect bonding from shore to ship and close the grounding switch. Board the ship and gage, sample all cargo tanks, before and after readings. Couple cargo hose from shore to ship and make preoperationsl checks to prevent oil spills. Discharge cargo from ship to base terminal. Unload the ship using shore base facilities. Fill out tanker discharge report form DD 250-1. Issue a dry tank certificate. Name three ways to clean up oil spills.		
References:	TM 10-1101; TF 10-2855, POL Pier Operations; TM 10-1118; Chap II; MF 7790 Measuring and Sampling Barges Tankers (16) (B/W) QMS 300.512		

Annex E - Military Pipeline Operations

Purpose - To provide knowledge of military pipeline operations, practices, and procedures, and the operation and maintenance of pipeline equipment.

NOTE: This Annex can be partially accomplished by taking QM Subcourses:
142: √ Petroleum Equip & Tech Procedures
401: Pipeline Operations
474: Pipeline Operations
581: Pipeline Maintenance & Security

File No		Clas	Type of Instruction
E-1	Introduction		
Hours	2	U	1.5C, .5TV
Objective:	Identify the contents of "E" Annex. Identify the advantages and disadvantages of Military Pipeline.		
References:	TM 5-343; TM 10-1118; HRE-7 Military Pipelines System CBI Theater (23) (B/W), QMS 300.401		
E-2	Operation of the 4-inch, 4-stage Pump		
Hours	7	U	2C, .5D, 4.5PE1
Objective:	Perform operator maintenance. Prepare DA Form 2404 and 2408-1. Operate the four-inch, four-stage pumping unit. Identify safety checks required in all pumping operations. Identify the proper suction and discharge pressure for normal pumping operations.		
References:	TM 5-4320-210-12; TM 38-750, Chap 2 & 3; QMS 300.402		
E-3	Operation of the 6-inch, 2-stage Pump		
Hours	2	U	.7C, 3D, 1PE1
Objective:	Perform preoperational maintenance and safety check. Identify the difference between series and parallel connection. Operate the six-inch, two-stage pumping unit. Identify procedures for setting safety control switch.		
References:	TM 5-9427; TM 5-4320-217-15, Chap 1, 2, 3; TM 10-1109, Chap 4; TM 10-1118; Chap 3, 4; QMS 300.404		

File No		Clas	Type of Instruction
E-4	Pipeline Maintenance		
Hours	4	U	1.4C, .5D, 1.5PE1, .2PE2, .4TV
Objective:	Identify four methods of repairing coupled pipeline leaks. Fill out a leak report, DA Form 10242. Locate leaks in a pipeline by patrolling. Identify the different methods of patrolling.		
References:	AR 420-56; TM 10-1109, Para 7, 13, 17, 20; TF 5-1862 Military Pipeline Operations, Part I - Laying Pipelines; QMS 300.405		
E-5	Pump Station Operations		
Hours	16	U	1.3C, .5PE2, .5D 13.5PE1, .2TV
Objective:	Perform inspection and prepare station for receipt of pumping order. Put pumping station on line when proper suction pressure is observed and in the correct sequence. Rotate pumping units and perform operator maintenance. Identify and execute all pumping orders. Conduct scraper operations as required.		
References:	TM 10-1109; Para 9 and 10. TM 10-1112, Para 6, 8-10 and 20; TM 10-1118, Chap 3; VT 127 Scrapers & Sandtraps QMS 300.402		
E-6	Operate multi-Product Pipelines		
Hours	3	U	2C, 1D
Objective:	Identify the proper sequence for batching a multi-product pipeline. Detect an interface by API gravity. Identify methods to dispose of interface with waste. Record time of color and gravity change. Identify proper gravity cut for interface.		
References:	TM 10-1101; Chaps 1-4; TM 1105; TM 10-1112; QMS 300.406		

44

File No		Clas	Type of Instruction
E-7	Hoseline Operations		
Hours	1	U	1TV

Objective: Identify the assault hoseline. Identify the intended use.

References: FM 5-343; Para 9-19; 9-25; VT-128, the 4" Petroleum Assault Hoseline; QMS 300.407

Annex Total 35

NOTE: Page Numbers 45-55 have been omitted; However all material is included.

56

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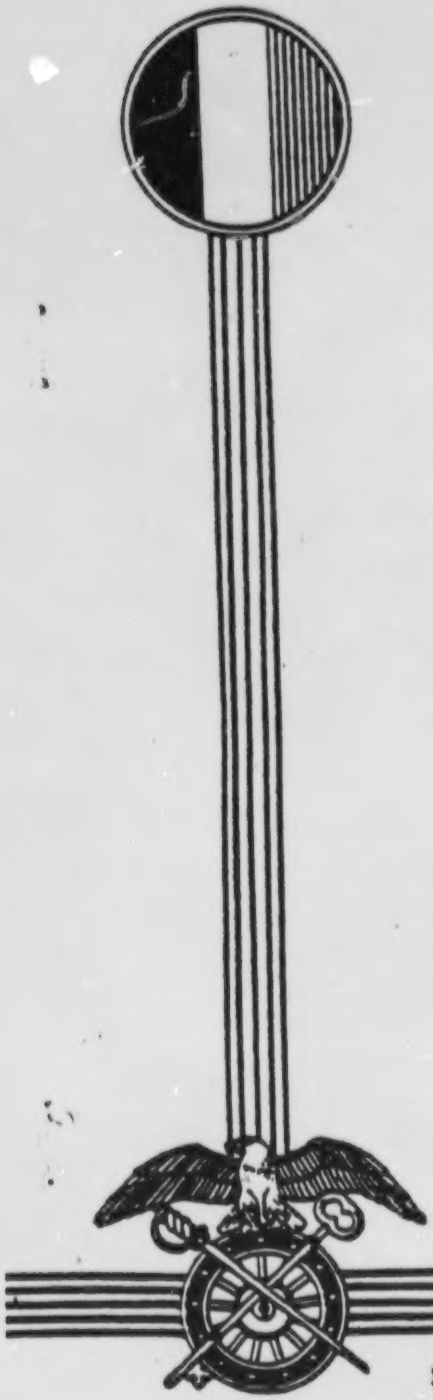

PETROLEUM SUPPLY SPECIALIST
MOS 76W10

INSTRUCTOR GUIDE
Annex A

U.S. ARMY QUARTERMASTER SCHOOL
FORT LEE, VIRGINIA

SUPPLY TRAINING CENTER OF THE ARMY SCHOOL SYSTEM

ATSM-TNG-TM-ET

MAY 1978

Army-Fort Lee, Va.-0978-78-106-1

TABLE OF CONTENTS

PARAGRAPH	TITLE	PAGE
1	Purpose	1
2	Annex Goals	1
3	Instructional Organization and Responsibility	1
4	Student Morale and Control	1
5	Individualized Instruction	2
6	Control and Distribution of Materials	2
7	Student Records	2
8	Contents of Annex A	2
9	Conducting Instruction, Block A-1: Introduction to Petroleum Supply Specialist	2
10	Conducting Instruction, Block A-2: Categories of Petroleum Products	4
11	Conducting Instruction, Block A-3: Visual Examination and Contamination of Bulk Petroleum Products	5
12	Conducting Instruction, Block A-4: Petroleum Health and Handling Hazards	6
13	Conducting Instruction, Block A-5: Firefighting Equipment and Procedures	8
14	Conducting Instruction, Block A-6: The Army Maintenance Management System (TAMMS)	9
APPENDIX A	ANNEX MAP	11
APPENDIX B	INSTRUCTOR CONTROL CARD	12
APPENDIX C	REFERENCES	13

INSTRUCTOR GUIDE

76W, Petroleum Supply Specialist

Annex A, General Petroleum Subjects

1. PURPOSE. This guide provides you, the instructor, with the necessary directions to conduct the course. This guide is not a technical manual of subject matter covered in this annex. When questions arise for which you cannot find the answers in this guide, use the references listed with each block of instruction.

2. ANNEX GOALS. The goals of this annex are to teach enlisted personnel some of the basic information and job skills performed by petroleum supply specialists. In this annex the students will learn about the different categories of petroleum products used by the Army and how to check them for possible contamination. They will be taught health and safety hazards common to people who work in or around petroleum products. The different types of firefighting equipment used to prevent or contain petroleum fires are also presented. At the option of the instructor, basic math review, the TA-312/PT field telephone, and the AN/PRC-77 radio set may be taught (blocks A-6, A-7, and A-8, respectively). The DA and DD forms used by petroleum personnel under The Army Maintenance Management System (TAMMS) are also included in this annex.

3. INSTRUCTIONAL ORGANIZATION AND RESPONSIBILITY. If you have a sufficient number of qualified personnel, a team of instructors should be formed. The team should consist of a team chief (E6 or E7) and an assistant instructor (E5 or E6) for each six to eight students. The team chief is the senior instructor responsible for the overall conduct of instruction. This arrangement eases the job of training and lends itself to individualized instruction.

4. STUDENT MORALE AND CONTROL. As an instructor, you should be alert to signs of student difficulties and make every effort to solve problems. Students who progress rapidly should be allowed to go on to the next lesson, or be assigned as student aids to help other students with learning difficulties. Students who are slow but conscientious workers must be encouraged to continue studying. Never ridicule a student. Give praise and commendation for progress whenever merited. Students who refuse to apply themselves or do not pay attention should be counseled. Students who continue to have problems not directly related to learning difficulties (i.e., inability to read or comprehend) should be referred to command.

5. INDIVIDUALIZED INSTRUCTION. Individualized instruction is tailored to the needs of the student. The instructor should circulate among the students to answer questions and insure they will finish in the prescribed time. Text materials are written at the seventh to ninth grade reading level. This will be well within the grasp of most students; however, instructors should be alert for students with reading comprehension problems.

6. CONTROL AND DISTRIBUTION OF MATERIALS. This is a self-paced course. Students should be free to progress through the annex at their own speed. Before beginning a block of instruction, you should provide your students with all handouts, references, and programed texts (PT's). When the student has completed the reading assignment and indicates that he/she is ready, administer the checklist examination. Students are expected to achieve a score of at least 70 percent in two attempts. A pretest counts as one attempt. Students should not be allowed to go on to a block of instruction until they have successfully completed all preceding blocks. Remember, all programed texts are self-teaching materials which contain step-by-step explanation and demonstration, review, and self-grading performance requirements. Because each instructional block includes a complete processing procedure, each block must be completed in the sequence shown on the annex map (Appendix A).

7. STUDENT RECORDS. Student folders and control cards must be prepared for each student enrolled in the course. These records should reflect the student's progress, time expended on each block of instruction, and examination scores. Copies of records, counseling, and other pertinent remarks you consider vital should be attached to the student control card. When a student completes an annex, you should give these records to the student's next instructor. A sample format is attached at Appendix B.

8. CONTENTS OF ANNEX A. This is the first annex in the MOS 76W course of study. Annex A contains nine blocks of instruction (A-1 through A-6) which must be completed by the student in numerical sequence. When the students have successfully completed all required work in this annex, they will know and be able to perform some basic skills of a petroleum supply specialist at skill level 1 under the Enlisted Personnel Management System (EPMS). A summary of the course content of each instruction block for Annex A follows.

9. CONDUCTING INSTRUCTION, BLOCK A-1: INTRODUCTION TO PETROLEUM SUPPLY SPECIALIST. This first block of instruction covers the duties performed by a petroleum supply specialist (MOS 76W, skill level 1). This MOS has promotion potential from grade E3 to E9 under the newly implemented EPMS. Also included are the origin and history of petroleum and the flow of petroleum cupplies from the Continental United States (CONUS)

to a theater of operations (TO). (NOTE. This block does not include specific acts or performances that students must master; however, performance objectives are specified in annex blocks A-2 through A-6 The information given in subparagraph a of each block is intended to guide the instructor when teaching the material. Particular attention should be given to this subparagraph since the Skill Qualification Test (SQT) taken by the student is based on material correlating with the instructional objectives in each block. It is important that the instructor plan his presentations around these objectives.)

a. Objectives.

(1) Condition. The student will be placed in the position of a petroleum supply specialist and given the job description of a petroleum supply specialist (MOS 76W) and the method of distributing petroleum products from CONUS to a theater of operations.

(2) Action. The student will—

(a) Prepare a task list showing at least 15 duties performed by a petroleum supply specialist at skill level 1 (formerly 76W20).

(b) Write a report of 100 words or less on the procedures for distributing petroleum supplies from CONUS to a theater of operations. Include in the report the supply units responsible for the flow of petroleum in the chain of command.

(3) Standard. The task list must contain the duties as described in AR 611-201. The flow of petroleum from CONUS to a theater of operations should be based on paragraph 9-27, FM 100-10.

b. Logistical Requirements.

(1) Materials: pen, pencil, paper, Student Guide.

(2) References: AR 611-201, Enlisted Career Management Fields and Military Occupational Specialties; FM 29-45, General Support Supply and Service in the Field Army; FM 100-10, Combat Service Support.

(3) Setups: classroom, desks, chairs.

(4) Allotted Time: 4 hours. (NOTE. The allotted time indicated for each block is not a fixed time limit. It is a suggested time frame based on past experience that the average student needed to complete the instruction block. Since this is a self-paced course of instruction, the instructor is free to increase or decrease the allotted time to each student's particular need or capability.)

61

(5) Equipment: none.

c. Directions for Carrying Out Instruction. Make sure the steps below are followed during your instruction:

(1) Step 1. Students should read and study AR 611-201, pages 3-92-1 through 3-92-7; FM 100-10, paragraphs 9-25 through 9-27.

(2) Step 2. Have students do assignment required in a(2)(a) (Action) above.

(3) Step 3. Have students do assignment required in a(2)(b) above.

(4) Step 4. When you are satisfied that the students have fulfilled the requirements of instruction block A-1, let them proceed to instruction block A-2.

10. CONDUCTING INSTRUCTION, BLOCK A-2: CATEGORIES OF PETROLEUM PRODUCTS. This block of instruction covers the four major categories of petroleum products that a petroleum supply specialist will work with or handle in his job assignment.

a. Objective.

(1) Condition. The student will be placed in the position of a petroleum supply specialist and given TM 10-1105 and QMS 300.026 PT covering the four major categories of military petroleum products.

(2) Action. The student will--

(a) Identify, list, and describe the four major categories of petroleum products used by the Army and give two examples of each category.

(3) Standard. The student must perform or answer correctly at least 70 percent of the performance tasks or written requirements administered in A-10.

b. Logistical Requirements.

(1) Materials: pen, pencil, paper, Student Guide.

(2) References: TM 10-1105, Inspecting and Testing Petroleum Products.

(3) Setups: classroom, desks, chairs.

(4) Allotted Time: 2 hours. (See paragraph 9b(4) for adjustment of time allotment.)

(5) Equipment: none.

c. Directions for Carrying Out Instruction. Make sure the steps below are followed during the instruction process:

(1) Step 1. Students should read and study the appropriate material in TM 10-1105 concerning the major categories of petroleum products.

(2) Step 2. Have the students do QMS 300.026 PT in pencil.

(3) Step 3. When you are satisfied that the students have adequately completed the programed text, let them proceed to instruction block A-3.

11. CONDUCTING INSTRUCTION, BLOCK A-3: VISUAL EXAMINATION AND CONTAMINATION OF BULK PETROLEUM PRODUCTS. This block of instruction covers the basics of visual examination of bulk petroleum products for purity. The student will learn how to identify various types of bulk petroleum products, to measure petroleum gravity, and to determine a product's gravity range according to American Petroleum Institute (API) criteria.

a. Objectives.

(1) Condition. The student will be placed in the position of a petroleum supply specialist situated in a petroleum training facility (PTF) and given samples of petroleum products, artificial coloring solution, a color chart, the observed API temperature of petroleum products, and API gravity chart, glass cylinder, and hydrometer.

(2) Actions. The student will—

(a) Use a color chart and identify a series of bulk petroleum product samples.

(b) Identify the contaminant(s) contained in samples of contaminated petroleum products.

(c) State three to five precautions that should be practiced in order to prevent contamination of petroleum products.

(d) Determine the weight or identification of petroleum product samples based on API criteria.

(e) Perform an API gravity test on a series of petroleum product samples.

(3) Standard. The student must perform or answer correctly at least 70 percent of the performance tasks or written requirements administered in A-10.

b. Logistical Requirements.

(1) Materials: pen, pencil, Student Guide, color chart, artificial coloring solution, petroleum product samples, glass cylinder.

(2) References: TM 10-1101, Petroleum Handling Equipment and Operations; TM 10-1166, 1972 Book of ASTM Standards.

(3) Setups: classroom, desks, chairs (PTF, if available).

(4) Allotted Time: 5 hours. (See paragraph 9b(4) for adjustment of time allotment.)

(5) Equipment: hydrometer.

c. Directions for Carrying Out Instruction. Make sure the steps below are followed during the instruction process:

(1) Step 1. Students should read and study appropriate material in TM 10-1101 and TM 10-1166 pertaining to visual examination, contamination, temperature, and API gravity range of petroleum products.

(2) Step 2. Have the students read and study QMS 300.656 H1 and do the practical exercises contained therein.

(3) Step 3. When you are satisfied that the students have adequately completed the practical exercises in the handout, let them proceed to instruction block A-4.

12. CONDUCTING INSTRUCTION, BLOCK A-4: PETROLEUM HEALTH AND HANDLING HAZARDS. This block of instruction covers the health and safety hazards involved in the handling of petroleum products and first aid treatment for injuries sustained while working with such products.

a. Objective.

(1) Condition. The student will be placed in the position of a petroleum supply specialist and situated in a training facility in which various types of petroleum products are handled on a routine basis. Appropriate technical manuals, health and safety guidelines, and

first aid procedures for treating petroleum related injuries are provided.

(2) Actions. The student will--

(a) Identify potential fire, safety, and health hazards in the handling of petroleum products.

(b) Identify safety precautions when working with or near petroleum products.

(c) State the proper first aid remedies for treating various injuries sustained from handling or working with petroleum products.

(3) Standard. The student must perform or answer correctly at least 70 percent of the performance tasks or written requirements administered in A-10.

b. Logistical Requirements.

(1) Materials: pen, pencil, Student Guide, gasoline, jet fuel, matches, cigar/cigarette, hammer, nails, oil-soaked rags.

(2) References: TM 5-687, Repair and Utilities; Fire Protection Equipment and Appliances; Inspections and Operations; TM 10-1101, Petroleum Handling Equipment and Operations.

(3) Setups: classroom, desks, chairs (PTF, if available).

(4) Allotted Time: 3 hours. (See paragraph 9b(4) for adjustment of time allotment.)

(5) Equipment: first aid kit.

c. Directions for Carrying Out Instruction. Make sure the steps below are followed during the instruction process:

(1) Step 1. Students should read and study paragraphs 149-153 in TM 5-687 and appropriate material in TM 10-1101 pertaining to petroleum health and handling hazards and first aid treatment.

(2) Step 2. Have the students read and study QMS 300.653 H1 and complete the exercises contained in the handout.

(3) Step 3. When you are satisfied that the students have adequately completed the exercises in the handout, let them proceed to instruction block A-5.

13. CONDUCTING INSTRUCTION, BLOCK A-5: FIREFIGHTING EQUIPMENT AND PROCEDURES. This block of instruction covers the four classes of fires and the procedures and equipment used for extinguishing them. In addition, inspection of fire extinguishers and the use of DA Form 253 (Fire Extinguisher Tag) are also taught.

a. Objectives.

(1) Condition. The student will be placed in the position of a petroleum supply specialist and given situations involving four major classes of fires, firefighting and rescue procedures, types of fire extinguishers, and inspection procedures used for checking fire extinguishers.

(2) Actions. The student will--

(a) Identify the four classes of fires and select the proper firefighting agent to extinguish the flame.

(b) Name the three essential elements that are needed to cause fires.

(c) Inspect fire extinguishers for serviceability.

(d) Outline the proper procedures for reporting a fire.

(e) Inspect fire extinguishers and complete DA Form 253.

(3) Standard. The student must perform or answer correctly at least 70 percent of the performance tasks or written requirements administered in A-10.

b. Logistical Requirements.

(1) Materials: pen, pencil, Student Guide, DA Form 253.

(2) References: TM 5-315, Firefighting and Rescue Procedures in Theaters of Operations; TM 5-687, Repair and Utilities; Fire Protection and Appliances; Inspections and Operations; TM 10-1101, Petroleum Handling Equipment and Operations.

(3) Setups: classroom, desks, chairs (PTF, if available).

(4) Allotted Time: 4 hours. (See paragraph 9b(4) for adjustment of time allotment.)

(5) Equipment: fire extinguishers.

c. Directions for Carrying Out Instruction. Make sure the steps below are followed during the instruction process:

(1) Step 1. Students should read and study all appropriate material in TM's 5-315, 5-687, and 10-1101 pertaining to classes of fires and firefighting equipment and procedures.

(2) Step 2. Have students do programed text QMS 300.865 PT.

(3) When you are satisfied that the students have learned the material in the programed text, let them proceed to instruction block A-6.

14. CONDUCTING INSTRUCTION, BLOCK A-6: THE ARMY MAINTENANCE MANAGEMENT SYSTEM (TAMMS). This block of instruction covers the basic information needed to prepare DA Forms under the Army Maintenance Management System (TAMMS). TAMMS is the Army's system of managing equipment operations and collection of significant maintenance data such as equipment transfers, modification work orders, and repair work. The system is also used to measure and evaluate the effectiveness of equipment for materiel readiness. Equipment deficiencies and maintenance support are also reported under TAMMS.

a. Objectives.

(1) Condition. The student will be placed in the position of a petroleum supply specialist and given TM 38-750, DA Forms 2400, 2404, 2408-1, and 2408-14, and problem situations related to the use and maintenance of Army equipment.

(2) Actions. The student will--

(a) Dispatch equipment by preparing DA Form 2400 (Equipment Utilization Record).

(b) Inspect equipment and prepare DA Form 2404 (Equipment Inspection and Maintenance Worksheet) to report equipment faults or defects.

(c) Maintain daily and monthly operational logbooks for equipment on DA Forms 2408-1 and 2408-14.

(3) Standard. The student must perform or answer correctly at least 70 percent of the performance tasks or written requirements administered in A-10.

b. Logistical Requirements.

(1) Materials: pen, pencil, Student Guide, DA Forms 2400,2404, 2408-1, 2408-14.

(2) References: TM 38-750, The Army Maintenance Management System (TAMMS).

(3) Setups: classroom, desks, chairs.

(4) Allotted Time: 2 hours. (See paragraph 9b(4) for adjustment of time allotment.)

(5) Equipment: none.

c. Directions for Carrying Out Instruction. Make sure the steps below are followed during the instruction process:

(1) Step 1. Students should read and study material in TM 38-750 that coincides with topics discussed in QMS 222.3-11 H1.

(2) Step 2. When you are satisfied that the students have adequately completed the exercises and PE's in this annex block, let them proceed to Annex C.

APPENDIX C

REFERENCES

ANNEX A

FM		
29-45	Jun 65	General Support Supply and Service in the Field Army
100-10	Apr 76	Combat Service Support
TM		
5-315	Apr 71	Firefighting and Rescue Procedures in Theaters of Operations
5-687	Dec 57	Repair and Utilities; Fire Protection Equipment and Appliances; Inspections and Operations
10-1101	May 72	Petroleum Handling Equipment and Operations
10-1105	Jan 72	Inspecting and Testing Petroleum Products
10-1166	May 73	1972 Book of ATSM Standards
38-750	Nov 72	The Army Maintenance Management System (TAMMS)

69

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PETROLEUM SUPPLY SPECIALIST
MOS 76W10

STUDENT GUIDE
ANNEX A

U.S. ARMY QUARTERMASTER SCHOOL
FORT LEE, VIRGINIA

SUPPLY TRAINING CENTER OF THE ARMY SCHOOL SYSTEM

ATSM-TNG-TM-ET
MAY 1978

QMS 300.024 H1

PETROLEUM SUPPLY SPECIALIST

76W20

INTRODUCTORY HANDOUT

PROPONENT DEPARTMENT: Petroleum and Field Services

November 1976

THIS SUPERSEDES QMS 300.024H1 DATED MAY 1973.

The 76W Basic Course is broken down into five basic annexes. The sum total of these annexes will familiarize you with most of the basic equipment that is used to do your job.

You will learn how to operate the different equipment in a safe and efficient manner. You will also learn the important safety rules and how to prevent and fight fires. You will also learn how to maintain your equipment to keep it in good working order.

In "A" Annex you will learn how to use maintenance forms to keep a record of equipment use and get repairs made. You will learn how to avoid health and safety hazards. You will learn about what kind of fuels, gasolines, and lubricants the Army uses and how to check it for quality.

In "B" Annex you will learn about the methods of storing and handling packaged products. Package products are fuels and lubricants, etc. that are kept in cans, drums, and boxes.

In "C" Annex you will learn about Class III operations. Most of the gasoline, diesel, and jet fuels we use are handled in bulk or large quantities. In this Annex you will learn about delivery trucks and several pumps from 50 gallons per minute (50 GPM) to 350 gallons per minute (350 GPM). You will learn how to layout and operate the Fuel System Supply Point (FSSP). The FSSP is best described as a portable gas station. Most units in the field are serviced by trucks and trucks usually get filled at the FSSP. You will also get to refuel airplanes and helicopters in this Annex.

In "D" Annex you learn about Terminal Operations. How to load and unload rail cars and ships, operate manifolds, and the six inch single stage pump. You also learn how to gage and sample storage tanks.

"E" Annex is your final annex. In this annex you will be familiarized with pipeline operations. The 76W operates several major pipelines that move huge quantities of fuel for long distances.

You can't hope to be an expert in all of these different tasks but you will be able to learn all the basics. The degree of proficiency you achieve will depend on your own effort. When you leave this school you will be expected to be able to do any of those tasks needed to keep "POL", "ON THE MOVE".

You have eight weeks in which to complete this course. You are to work at your own pace and if you make an effort you can complete this course early. If you waste time,it will be impossible for you to complete this course on time and if your record reflects that you are dropping behind the stage of the course where you should be, at a given time, you could be dropped from the course.

The instructors are required to note in your records any time you are sleeping or loafing or breaking any specific rules or regulations. There are some people who like to goof-off or loaf etc. Every effort is made by the personnel of this school to identify these people as quickly as possible and drop them from the course.

The students who are slow but who are sincerely trying will find the instructors will bend over backwards to help them. Attitude and desire are the two key factors in successful completion of this course. No student is accepted for this course unless they have met the necessary mental and physical requirements.

There are twelve examinations in this course and some of those are given in separate parts. Should you fail an exam you will restudy that subject and retest. Should you fail that test you could possibly be dropped from the course based on recommendations from your counselor. If you fail any three tests you will be dropped from the course.

Once again welcome to this course and the best of luck to you. Remember the Army and the Petroleum Family needs good people for a big job. It's all up to you.

73

QMS 300.024 H3

COURSE OUTLINE
PETROLEUM SUPPLY SPECIALIST COURSE

PROPONENT DEPARTMENT: Petroleum and Field Services

February 1977

New

74

Hi! Here is a handy dandy outline of the subject areas and exams you will have to complete in order to get through this course. If you keep this outline with you, or at least where you can find it, you'll be able to follow your progress through this course. There is even a nifty place to keep track of your test scores. The course is broken down into five (5) annexes, A, B, C, D and E, for general subject areas and each annex is broken down into specific subjects and exams. At the completion of "E" Annex you will receive a genuine (for real!) DIPLOMA. Sometimes too many students get into the same area, so to prevent people from being trampled we have to juggle the areas of study. Because of this you won't always get the subjects in the same order listed. You will, however, get all the subjects sooner or later.

"A" ANNEX

This annex is a wee bit tough since you have two exams, but at least it is short. You should be able to complete it all in about four days.

1. INTRODUCTION - Here's where you get all that good information, like this outline. You meet your counselors, get your books, and if you are lucky, you can meet some of the brass from the Head Shed. You will also get a block of instruction on radios and telephones. Stay awake for this block because it is a big chunk of the A-10 exam. Draw a circle around the "1" when you finish the introduction.

2. VISUAL EXAMINATION - Sometimes called A-3, comes complete with programed text, movie, practical exercise and examination. Here you will learn to spot contamination in fuels and run a laboratory type test to check the gravity of fuels. When you finish, record your test score here. ☐
A-3

3. CATEGORIES OF PETROLEUM PRODUCTS (A-2) - This is a programed text that clues you in on all the different types of petroleum products you will handle as a Petroleum Supply Specialist. It helps to know what you are working with.

4. HEALTH AND HANDLING HAZARDS (A-4) - The object of this programed text and movie is to teach you enough about petroleum hazards to keep you from getting burned, choked, poisoned or otherwise spindled or mutilated. An ounce of prevention is worth a pound of cure and saves on asprin. Study this one well.

5. FIRE FIGHTING (A-5) - Another self paced program and three "HOT" films. This block tells you how to fight fires but more important, how to prevent them. WARNING - it has been determined that fire can be hazardous to your health.

6. TAMMS (A-9) - This is a "no fun" programed text on how to fill out standard forms. You will be plagued forever with forms in the Army so here's your chance to learn how to fill them out. Learn to do it here and save some asprin later.

7. EXAMINATION (A-10) - This is a written exam on everything you learned in "A" Annex except A-3. Be sure you study your programs well and your notes on the radio and telephone class. If you fail to pass you have to start all over again and that is a drag. Put your test score for A-10 here. ☐ A-10

"C" ANNEX

For most students, this is a fun annex. After studying each subject with programed text and TV films you get to operate a piece of equipment and then take a performance exam. For the person who likes to work with their hands, this annex is a change to improve your scores and save time. "C" Annex covers Class III Supply Point Operations and most 76W personnel work in this type operation after leaving this school.

1. INTRODUCTION (C-1) - Here is a short little handout. No exam on this, but study the rules well to avoid getting in trouble later on.

2. 50 GPM PUMP AND 500 GALLON COLLAPSIBLE DRUM (C-2) - It never fails - someone will get doused with fuel on this one. It is usually the first time you have ever worked with a powered pump, but if you study the text and film well, you should be able to avoid getting wet. Having a good knowledge of how this pump and engine works will make all the other engines and pumps easier to learn. Put your test score here. ☐
C-2

3. TANK & PUMP UNIT (C-4) - This pump is almost identical to the 50 GPM. It is mounted with two tanks on a tactical cargo truck. Follow the program closely and understand the flow of fuel in the manifold and you should pass this test with ease. Put your test score here ☐
C-4

4. 350 GPM PUMP AND FILTER SEPARATOR (C-6) - Now you're getting into bigger operations. This pump is the main pump in the FSSP (Fuel System Supply Point). Study this pump and filter separator closely. The exam carries a lot of raw points. Put your test score here.

C-6

5. RIGGING FOR EXTERNAL HELICOPTER (C-5) - You got lucky on this block. Rigging for airlift is performed by professional riggers but you may be working with them sometimes. To familiarize yourself with this operation just sit back and enjoy a 30 minute film. It's actually a pretty good film and lucky you -- no exam on this.

6. OPERATION AND LAYOUT OF THE FSSP (C-7, C-10) - This block is going to require your thinking cap and a lot of muscle. The FSSP is designed to be moved frequently to stay close to combat units in the field. You will have to know how to set it up, take it down and operate it. The key to the whole thing is knowing how to control the flow of fuel in the system. Learn and really understand how to move the fuel the way you want it to and the rest is easy. The exam on this carries a lot of raw points. Put your test score here.

C-7

7. AIRCRAFT REFUELING (C-3, C-9 & M49C) - In this block you get a big load. You learn how to set up and operate the FARE System, operate the 100 GPM pump and separator, and how to operate the M49C tank truck. You will take two exams on this at this station, one for the FARE System and one for the M49C. Put your test score here. ☐

8. TANK VEHICLE OPERATIONS (C-8) - There are two programed texts. One for the M49C, 1200 gallon tanker and one for the M131, 5000 gallon tanker. You also have two films to see. There is also a briefing on the operation of the GOER, M559 tank truck. You won't be tested on the GOER but you may someday soon be using it so take good notes and pay attention. Put your test score here. ☐

"D" ANNEX

This annex is devoted to Terminal Operations. The Army handles vast quantities of bulk fuels. As a result there are large tank farms and terminals to handle this big job. In this annex you will learn some of the tasks you will have to perform as a 76W if assigned to one of these terminals.

1. GAGING AND SAMPLING OF STORAGE TANKS (D-2, D-4) - Here is where a lot of students get in trouble. The main reason they get in trouble is because they try to rush through this block then find out that two exams are based on what they were supposed to have learned here. Gaging and sampling is one of the most important jobs you will ever have to do. You have three films and two programed texts to complete before doing the programed practical exercise. Study your programs carefully and follow directions closely. You will get an exam on this when you finish but it is only one part of a three part exam. You will get the total score when you finish part III of D-11 exam.

2. VOLUME CORRECTIONS (D-3) - If you can add, subtract, and multiply, this will be a snap. If you have trouble with math this is a headache for sure. Put your score here. ☐

3. VALVES, PIPES AND FITTINGS (D-5) - This programed text explains different types of valves, what they are used for and how to service them. You shouldn't have any problem here if you study the program carefully.

4. MANIFOLDS (D-6) - The first time you look at a manifold system with all its pipes and valves you might be reminded of a Chinese jigsaw puzzle or a for real nightmare. The programed text on this makes it easy if you follow it step by step very carefully.

5. TRANSFER PUMP (D-7) - In this block you'll learn how to operate and maintain the six inch single stage pump. This is the biggest pump you have had yet. You will also find it is one of the easiest to operate.

6. RAIL TANK CARS (D-8) - In this block you learn how to load and unload the rail tank car. You will be working with other students who are operating the manifold and transfer pump when you load and unload the rail tank car. Be sure you do everything the programed text requires. You have to gage and sample the rail car in this block also. After you finish this you'll get Part II of D-11 exam. Part II cover D-5, D-6, D-7 and D-8.

7. TANK MAINTENANCE (D-9) - This program is short and sweet. You won't have to clean any storage tanks in this course but you must learn to use the safety equipment so if you get on a tank cleaning team you will know how to work safely.

8. WATERFRONT OPERATIONS (D-10) - In this block you will learn the safe way to load, unload and gage sea going tankers. The big thing here is safety and which forms to fill out. Namely the DD 250-1 and the dry tank certificate. After this block you'get Part III of D-11 exam. Now you get a total score for D-11.

"E" ANNEX

This is your final annex. You will get this whole annex in what we call "LOCK STEP." This means no more programed text. You will go through this annex with a group of students and the instructors will teach the whole annex to you. In this annex you will learn to operate the pipeline pump station and four inch four stage pump. You will learn how to patrol a pipeline and make temporary repairs. You will also get to see the glass pipeline in operation and see how a multi-product pipeline works. The exam is a tough one so stay awake. Put your score here.

Well there you have it in a nutshell. After you successfully complete "E" Annex you will get a diploma and be welcomed to the POL family. You will be part of a big, hard working bunch of drum humpers who keep the Army moving. Good luck and have a great career!!

QMS 300.026 PT

U. S. ARMY QUARTERMASTER SCHOOL

PROGRAMED TEXT

CATEGORIES OF PETROLEUM PRODUCTS

PROPONENT DEPARTMENT: Petroleum and Field Services

May 1976

A-2

CATEGORIES OF PETROLEUM PRODUCTS

Introduction

How many times have you been lectured by a person not completely familiar with a subject? You get the feeling that you know more on the subject than he does! When a good salesman talks to you he knows the product. You as Petroleum Supply Specialist must know the petroleum products with which you will be dealing. This lesson will teach you the four (4) major categories of petroleum products that you as a 76W20 will deal with constantly.

Objective

1. Given the four (4) major categories of petroleum products the student will be able to identify, list and describe each of them.

2. The student will be able to give two (2) examples of each category.

Instruction

This text is made up of nine lessons. Read each lesson carefully and follow the instruction given. If at any time you have any questions, don't hesitate to ask your instructor for help.

GOOD LUCK !

Section A

Military Petroleum Categories

Military petroleum products fall under one of the four (4) categories listed below.

1. Automotive and aviation fuels
2. Burner fuels
3. Lubricants
4. Speciality items

NOTE: Turn to page 7, follow the instructions given under Section A.

NOTE: Each category has at least two examples of petroleum products you will be required to know. All of the categories will be discussed in separate sections. Keep in mind that questions will follow each section in this lesson booklet. Read each section carefully and follow the instructions given.

Section B

1. Automotive and Aviation Fuels

a. Mogas: In the military the term mogas is used instead of automotive gasoline. Gasolines are produced in different grades and types depending on the requirement of the engines and equipment in which the product is used. Gasolines are purchased in both regular and premium grades in three classes

Class A - for temperatures 50°F to extreme heat

Class B - for temperatures 25° to 70°F

Class C - for temperatures from extreme cold to 45°F

Note: Turn to page 7 and follow the instructions given.

Section C

b. Combat mogas: This grade of mogas comes in two types. Both types are used in automotive and stationary engines. To keep from having different grades of gasoline in the military supply system outside the United States combat gasoline is the only gasoline supplied in overseas areas.

Types of combat mogas: Type I - temperatures above $0^{o}F$.

Type II - temperatures below $32^{o}F$

NOTE: Turn to page 7, follow the instructions given.

Section D

c. Aviation gasoline: Avgas is the word used for aviation gasoline. Avgas is used in reciprocating piston type aircraft engines, not jet engines. The word reciprocating refers to the piston in the cylinder working back and forth in a straight line. Aviation gasoline is not made for motor vehicles. Avgas is procurred by the military in one grade, 100/130.

NOTE: Turn to page 8, follow the instructions given.

Section E

d. Jet fuels: Jet fuels differ from aviation gasoline because they do not contain lead. There are two principle grades of jet fuels used by the military, JP4 and JP5.

JP4, used for land based aircraft, while JP5 is used exclusively by the Navy for jet aircrafts aboard aircraft carriers. The primary users of JP4 are the U. S. Army and the U. S. Air Force for jet turbine engines. JP4 is a blend of highly refined kerosene and gasoline. It is clear to straw yellow in color.

NOTE: Turn to page 8, follow the instructions given.

Section F

e. Diesel fuel oils: There are two general classifications of diesel fuels. Those intended for shipboard use and those for general purposes.

1. Fuel Oil Marine, used in submarines and other shipboard operations at temperatures above 10°F.

2. Fuel Oil Diesel (DF-2) a general purpose fuel oil supplied in several grades depending upon specific usage.

a. Grade DFA (Arctic) used in high speed automotive diesel engines and pot type burner space heaters at temperatures minus 25°F.

b. Grades DF-2 (heavy) used in low and medium speed engines at temperatures above 20°F.

NOTE: Turn to page 9, follow the instructions given.

2. Burner Fuel

Section G

a. Burner fuels either generate power or heat for boilers or furnances. Burner fuels are used by the Navy in combat vessels.

b. Kerosene, classified as burner fuel, because of its use in wick-fed lamps and for cooking, heating, and other general purposes such as cleaning tools and equipment.

3. Lubricants

Section H

Lubricants are oils and greases used to reduce friction between moving surfaces. Its second most important function is to remove heat generated in the equipment being lubricated.

a. Lube oils: There are various grades of lubricant oils, each serves a specific purpose. The most common grades you will see are 10, 30, 40 and 90 gear oil.

b. Society of Automotive Engineers (SAE) numbers are used in order to avoid confusion in the minds of purchasers. SAE numbers for example are SAE 102-, SAE 10-30. Instead of such terms as light, medium, medium heavy, heavy, and extra heavy these numbers are used. The numbers are displayed on containers.

c. Greases are blends of lubricating oils, soaps, and/or other bases for thickness plus various additives. Greases are used where oils cannot adequately do the job, for example, automotive bearings and axels where oils could not be retained or dirty, dusty or wet conditions exist, where an effective seal against foreign matter is needed.

NOTE: Turn to page 9, follow the instructions given.

4. Specialty Items

Section I

Specialty items are those which can be used for one specific task only. Such items as solvents, dry cleaning, hydraulic fluids, cutting and insulating oils, anti-freeze, coolents, protective compounds, waxes, etc.

NOTE: Turn to page 10, follow instructions.

SELF TEST

Section A - Categories of Petroleum Products

Directions: List the four (4) categories of petroleum products.

1.

2.

3.

4.

Direction to student: Check your answers on page 11 and read the direction to student.

Section B - Automotive and Aviation Fuels

Directions: Fill in the blank space in items 1-3 with the correct word.

1. What military word is used for automotive gasoline? ____________________

2. Gasolines are procurred in two grades, name the grades. ________________

____

3. Situation: You are located in the dessert, which class of automotive gasoline will you use in a jeep? ________________________________

Direction to student: Check your answers on page 11, and read the direction to student.

Section C

Directions: Fill in the blank space in items 1-3 with the correct word.

1. What are the two types of combat mogas? ____________________________

____

2. Combat mogas is used in what areas? ______________________________

3. What temperature is type I used at? ______________________________

Direction to student: Check your answers on page 11 and read the direction to student.

93

Section D

Directions: Fill in the blank space in items 1 and 2 with the correct word. Put a check mark in one of the spaces marked yes or no.

1. What is the only grade of aviation gasoline procurred by the military?

____

2. What type of aircraft use Avgas? ______________________________

3. Can Avgas be used in motor vehicles? Yes __________ No __________

Direction to student: Check your answers on page 12 and read the direction to student.

Section E

Directions: Fill in the blank space for item 1-4 with the correct word.

1. Name the two principal jet fuels used by the military.

______________________ ______________________

2. What type of aircraft engine uses jet fuel? ______________________

3. Which one of the jet fuels is used by the Army? ______________________

4. Which jet fuel is used on aircraft carriers? ______________________

Note: Check your answers on page 12

Section F

Directions: Fill in the blank space in items 1-3 with the correct word.

1. What are the two classifications of diesel fuels?

_______________ _______________

2. Diesel fuel grade 2 (DF-2) is used in what type of engines?

_______________ _______________

3. Submarines use what type of diesel? _______________

Direction to student: Check your answers on page 12 and read the direction to student.

Section G

Directions: Fill in the blank space in items 1 and 2 with the correct word. Item 3 - check either yes or no.

1. Burner fuel generates power and _______________ for boilers on furnances.

2. What type of vessels use burner fuel? _______________

3. Is kerosene classified as burner fuel? Yes __________ No __________

Direction to student: Check your answers on page 12 and read the direction to student.

Section H

Directions: Fill in the blank space in items 1-2 with the correct word. Item 3 - check either yes or no.

1. Name the first and second main function of lubricants. _______________

____

2. What is the meaning of SAE? _______________

3. Greases are used when oil cannot do the job. Yes __________ No __________

Note: Check your answers on page 13.

95

Section I

Directions: Fill in the blank space with the correct word.

1. Wax is considered a ______________________________

Note: Check your answer on page 13.

SOLUTION

Section A

1. Automotive and aviation fuels
2. Burner fuels
3. Lubricants
4. Specialty items

Directions to student: If your answers agree, go to page 2 and read Section B. If your answers do not agree, go back to Section A, read and correct your answer, then go to Section B, page 2.

Section B

1. Mogas
2. Regular and premium
3. Class A

Directions to student: If your answers agree, go to page 3, and read Section C. If your answers do not agree, go back to Section B, read and correct your answers, then go to Section C, page 3.

Section C

1. I and II
2. Overseas
3. Above 0^oF

Directions to student: If your answers agree, go to page 3 and read Section D. If your answers do not agree, go back to Section C, read and correct your answers, then go to Section D, page 3.

97

Section D

1. 100/130

2. Receprocating piston engine

3. No

Directions to student: If your answers agree, go to page 4 and read Section E. Of your answers do not agree, go back to Section D, read and correct your answers then go to Section E, page 4.

Section E

1. JP4, JP5

2. Jet turbine engines

3. JP4

4. JP5

Directions to student: If your answers agree, go to page 4 and read Section F. If your answers do not agree, go back to Section E, read and correct your answers, then go to Section F, page 4.

Section F

1. Shipboard and general purpose

2. Low speed and medium speed engines

3. Diesel fuel marine

Directions to student: If your answers agree, go to page 5 and read Section G. If your answers do not agree, go back to Section F, read and correct your answers, then go to Section G, page 5.

Section G

1. Heat

2. Combat vessels

3. Yes

Directions to student: If your answers agree, go to page 5 and read Section H. If your answers do not agree, go back to Section G, read and correct your answers then go to Section H, page 5.

Section H

1. Reduce friction, remove heat

2. Society of Automotive Engineers

3. Yes

Directions to student: If your answers agree, go to page 6 and read Section I. If your answers do not agree, go back to Section H, read and correct your answers then go to Section I, page 6.

Section I

1. Specialty item.

Directions to student: If your answers agree with the solutions, you have completed this text. If you feel you know the material in this program raise your hand and the instructor will give you the next test. If your answers were incorrect go back to Section I, read and correct your answer, then raise your hand the instructor will give you the next test.

99

QMS 300.656 H-1

VISUAL EXAMINATION
AND
CONTAMINATION

PROPONENT DEPARTMENT: Petroleum & Field Services

Dec 77

Supersedes QMS 300.656 H-1, Oct 76

VISUAL CONTAMINATION AND EXAMINATION

HOW TO USE THIS PROGRAM:

All directions for you to follow are spelled out in this program. Read each page carefully, and perform whatever action you are told to do. Read everything thoroughly before attempting to answer any questions. Everything you need is set up for your convenience. If you have any questions, your instructor will assist you. Work through the program at your own pace. Go to study area #4 in building 11400 and begin.
GOOD LUCK!

DIRECTIONS TO INSTRUCTOR:

Review Self-Evaluation with students. Critique students on the test.

INTRODUCTION:

Have you ever gone to a service station and asked the attendant for premium and the attendant put regular in by mistake? Then, after about five or six gallons you call out, "Hey, I wanted high test!" What has happened is that you have just contaminated your fuel. Had you made a visual check to insure that the attendant put in premium, you would not have paid for product that you did not want.

OBJECTIVE:

As a result of completing this lesson, you will be able to:

1. Visually examine bulk petroleum products.
2. Recognize contaminated bulk petroleum products.
3. Identify various types of bulk petroleum products.
4. Measure and determine API gravity range for a petroleum product.

INFORMATION TO STUDENTS:

This lesson will teach you step-by-step, the basics of visual examination and contamination of bulk petroleum products. You will learn how to identify various types of bulk petroleum products and will be shown how to measure API gravity and determine a product's API gravity range. To perform a visual examination you must report the color, appearance and API gravity.

TURN PAGE
GOOD LUCK!

LESSON #1:

As a Petroleum Supply Specialist it is absolutely necessary that you be able to quickly identify a product by it's color. AVGAS and MOGAS contain tetra-ethyl lead and therefore must be dyed. Below is a list of the different bulk products you will handle. You must MEMORIZE these colors.

Aviation - Blue (grade 100LL)

Automotive - Amber (Commercial)

Automotive - Red (Combat)

Kerosene - Clear

Jet Fuels - Clear to light straw

Diesel Fuel - Straw to dark yellow

Heavy Burner Fuel - Black

102

PRACTICAL EXERCISE FOR LESSON #1:

1. What color is combat gasoline (automotive)? ____________________

2. What color is AVGAS (aviation 100LL)? ____________________

3. What color is JP4 (jet fuel)? ____________________

4. What color is diesel fuel (DFM)? ____________________

5. Does JP4 contain lead? Yes or No ____________________

6. Which products contain lead? ____________________

7. What three things must you report when performing a visual examination? (1)________________ (2) ______________ (3) ________

ANSWERS FOR PRACTICAL EXERCISE #1:

1. Red
2. 100LL Blue
3. Clear to light straw
4. Straw to dark yellow
5. No
6. MOGAS (automotive) and AVGAS (aviation)
7. Color, appearance and API Gravity.

NOTE: If you have answered all the questions correctly, go on to Lesson 2. If your answers do not match the above, go back and review Lesson 1, correct your answers, then do Lesson 2.

LESSON #2:

You will learn about API gravity. What does API stand for -- American Petroleum Institute. API gravity is the gravity or density of a petroleum product. All petroleum products are lighter than water; therefore, they float on water. We can say API is the weight of a product. Under this system, API gravity numbers or degrees are grouped by product weight. For example, fuel oil has a range of 10-35 API degrees. (See Figure 1). Read carefully each product API range. The higher the API number the lighter the product by actual weight.

Products	API Degrees Range
Solvents	40 to 100
Gasolines	55 to 75
Jet fuels	35 to 60
Kerosene, Diesel	30 to 50
Fuel Oils	10 to 35
Lub Oils	20 to 30
Water	10

FIGURE 1

PRACTICAL EXERCISE FOR LESSON #2:

1. What product has the widest API range? ______________________________
2. Which product is heavier, kerosene or gasoline? ________________
3. What does API stand for? ____
4. When you take an API, you are checking the __________________________

ANSWERS TO PRACTICAL EXERCISE #2:

1. Solvents

2. Kerosene

3. American Petroleum Institute

4. Weight or gravity of the product.

NOTE: If your answers do not agree review lesson #2. When you are satisfied with the answers tell control center you are ready to see the TV Film on API Gravity.

LESSON #3:

You will be required to perform a visual examination but before you can do that you must learn all the correct steps in doing the API test and learn how to convert your findings to the corrected API. Below is a list of all the steps in proper sequence. Study these steps closely.

a. Inspect your clear glass cylinder to insure that it is clean and dry.

b. Check the cap on the sample can, and make sure it is tight. Hold the can with both hands keeping the palm of one hand against the cap, turn the can upside down, and shake violently for about 30 seconds.

c. Pour a small amount of sample into the cylinder. (About one inch in the cylinder).

NOTE: When pouring from a sample can, grasp the can with your right hand so that the opening is at the large knuckle of your hand. With your left hand, hold the cylinder under the lip of the sample can hole. Tip the can to your left.

d. Rinse the cylinder walls with small amount of sample and discard this in the can marked "SLOP".

e. Reshake the samples as you did in step "b"; then, fill the cylinder 3/4 full.

f. Hold the cylinder up to a strong light and make a note of any contamination you see and also the color so it can be reported.

g. Set the cylinder on a level surface; then, select the hydrometer with the highest numbers.

106

h. Glently lower the hydrometer into the sample until it floats. If the surface of the sample does not cut the scale on the hydrometer, exchange the hydrometer for another with the next lower set of numbers. Repeat until you get the right hydrometer. See Figure 2, Page 16 .

i. Gently grasp the top of the hydrometer, center it in the middle of the cylinder and spin. This keeps the hydrometer from sticking to the side of the cylinder.

NOTE: If the hydrometer is touching the side of the cylinder, you will get a false reading.

j. Wait until hydrometer stops spinning.

k. Read the hydrometer. Keep your eye level just below the meniscus and read the hydrometer to the nearest scale division where the bottom of the meniscus cuts the scale. See Figure 3, Page 16 .

NOTE: The miniscus is that area of fuel at the top of the fuel which looks like a plate floating on the fuel.

l. Record the hydrometer reading to the nearest 1/10 degree API.

m. Read and record the temperature to the nearest degree, Fareinheit.

n. Repeat steps g thru k at least twice to insure your accuracy.

PRACTICAL EXERCISE FOR LESSON #3:

1. What is the hydrometer used for? ____________________

2. What do you check for before inserting hydrometer? ____________________

3. What is the eye level when reading the hydrometer? ____________________

4. Hydrometer sticks to side of cylinder, what action do you take? ____________________

ANSWERS TO PRACTICAL EXERCISE #3:

1. Taking API.
2. Contamination, color, and air bubble.
3. Below the fuel level, raise eyes until a straight line.
4. Spin.

NOTE: After completing this exercise review the TV film on the API test. Then do Lesson #4.

LESSON #4:

Petroleum products expand and contract or shrink according to the temperature. An example, in hot weather fuel expands, in cold weather, it contracts or shrinks. In order to insure that temperature changes are compensated for, when taking an API gravity, you must take the temperature of the fuel and correct the API gravity to 60°F.

Look at Table 5, Reduction of Observed API gravity to 60°F. (pages 17 - 27)

Assume you recorded a sample of JP4 at an API of 51 and an observed temperature of 71°F. What would the corrected API be at 60°? Look at Table 5.

First go to the observed API 51° at the top of the chart of Table 5. Now, go down the column under 51 until you see 71° at the left of the page. You should have a corrected API of 49.9 at 71°F.

TRY THESE TWO: Write in the corrected API in the far right column.

Observed Temp ° F	Observed API	Corrected API
60	52	
86	59	

Assume you have a recorded API of 51.6 at a temperature of 71°. First go to the observed API on Table 5. You see that there is no API of 51.6. Because of this, we must figure the corrected API of two API's, one on each side of 51.6 and both of 71°F.

Observed Temp °F	Observed API	Corrected API
71	51	49.9
71	51.6	?
71	52	50.9

Above you, notice the corrected API for 51 and 52 from Table 5. Your reading of 51.6 falls between 51 and 52. To get the corrected API at 51.6 is easy if you follow the step-by-step method. There are 10/10 between each whole number. First, subtract the difference between the corrected API's (50.9 - 49.9 = 1.0). Divide this by 10 (1.0 ÷ 10 = 0.1). This means that each tenth of observed API is worth 0.1. You have six of these (5.6) so multiply: 6 x 0.1 = 0.6. The last step is to add this to the lower of the two known corrected API's (49.9 + 0.6 = 50.5 @ 60°F).

In this case, 0.1 observed API was equal to 0.1 corrected API. This isn't always the case. Example: If you calculate 58.5 API @ 85°, you will find that 0.1 observed API is only 0.09 corrected API. Follow the steps through until you are sure you can do this; then do practical exercise #4.

PRACTICAL EXERCISE FOR LESSON #4:

	Observed Temp °F	Observed API	Corrected API
1.	68	53.2	
2.	72	38.5	
3.	86	25.7	
4.	85	50.9	

ANSWERS FOR PRACTICAL EXERCISE #4:

1. 52.4

2. 37.6

3. 24.1

4. 48.5

NOTE: If you have answered all the questions correctly do Lesson 5. If your answers do not match, go back and review Lesson 4. Correct your answers, then continue to Lesson 5.

LESSON #5:

"Rule of Thumb" Method of Correcting API:

1. The "Rule of Thumb" method for correcting API's is a field expedient method. It is not as accurate as Table 5 correction and should not be used when Table 5 is available.

2. The observed API gravity reading will change approximately 1/10° API for each degree of fahrenheit temperature change. Below 60°F you would subtract the correction. An easy way to remember the "Rule of Thumb" is to remember the three steps.

a. Step one: Find the difference between observed temperature and 60°F.

b. Step two: Divide the difference by 10.

c. Step three: If the observed temperature was above 60°F subtract the correction to the observed API. If the observed temperature was below 60°F add the correction to the observed API.

3. You have recorded an API of 63.5 at 77°F. To apply the "Rule of Thumb", follow these steps:

a. Step one: 77° - 60° = 17°

b. Step two: 17 ÷ 10 = 1.7

c. Step three: 77° is above 60° so now subtract your correction from 63.5 (63.5 - 1.7 = 61.8).

4. By "Rule of Thumb" you corrected API 63.5 @ 77° to API 61.8 @ 60° F.

NOTE: Do the following problems using the "Rule of Thumb" method.

PRACTICAL EXERCISE FOR LESSON #5:

Observed Temp °F	Observed API	Corrected API
1. 100	52.0	
2. 48	32.0	
3. 80	75.0	

ANSWERS TO PRACTICAL EXERCISE #5:

1. 48.0

2. 33.2

3. 73.0

NOTE: If you have answered all the questions correctly, go on to Lesson #6. If you have any problems ask an instructor to clear them up before going on.

LESSON #6:

Now that you are familiar with the API gravity and the color you must learn to identify the FOUR major contaminants commonly found in fuels.

1. WATER: Water can be seen as free water visible at the bottom of the fuel. It can also be seen as entrained or dissolved water which makes the fuel look cloudy or hazy.

2. SOLIDS: Solids are small bits or pieces of rust, sand, dirt, paint chips or fibers that can be seen with the eye.

3. COMMINGLING: Commingling is just a big word that means two or more fuels mixed together. If JP-4 (which is clear) and MOGAS (which is red) were mixed together the sample would be pink.

4. MICROBIOLOGICAL GROWTH: Microbiological growth is actually living bacteria found in the fuel. It is usually found between the water and fuel at bottom of a tank. Sometimes called FUNGUS it lives in the water and feeds on the fuel. It is seen in a sample as a lacy scum between the water and fuel.

YOU MUST REMEMBER THE FOUR MAJOR COMTAMINATES ABOVE!

PRACTICAL EXERCISE IN THE PTF

After you have studied lessons 1 thru 6 you are ready to go to the PTF for a practical exercise and an examination. In your practical exercise you must do three things:

1. Study the sample bottles that show the different colors of product.

2. Study the sample bottles containing the different types of contaminants.

3. Run an API test following the steps in Lesson #3 and convert the readings using Table #5 and the "Rule of Thumb".

When you are ready for the practical exercise tell the "C" annex Training Manager in Bldg 11400 and he will schedule you for the exercise. Upon the completion of the exercise the instructor will give you the A-3 examination.

REMEMBER

If you should suspect a fuel is contaminated in any way -- Do not use it until the laboratory has tested it.

REPORT

When reporting the results of a visual examination you must report COLOR, APPEARANCE, API GRAVITY.

1. COLOR - Report the actual color of the sample.

2. APPEARANCE - Report any contamination you find and if there is NONE report it CLEAN & BRIGHT.

3. API GRAVITY - Report the corrected API.

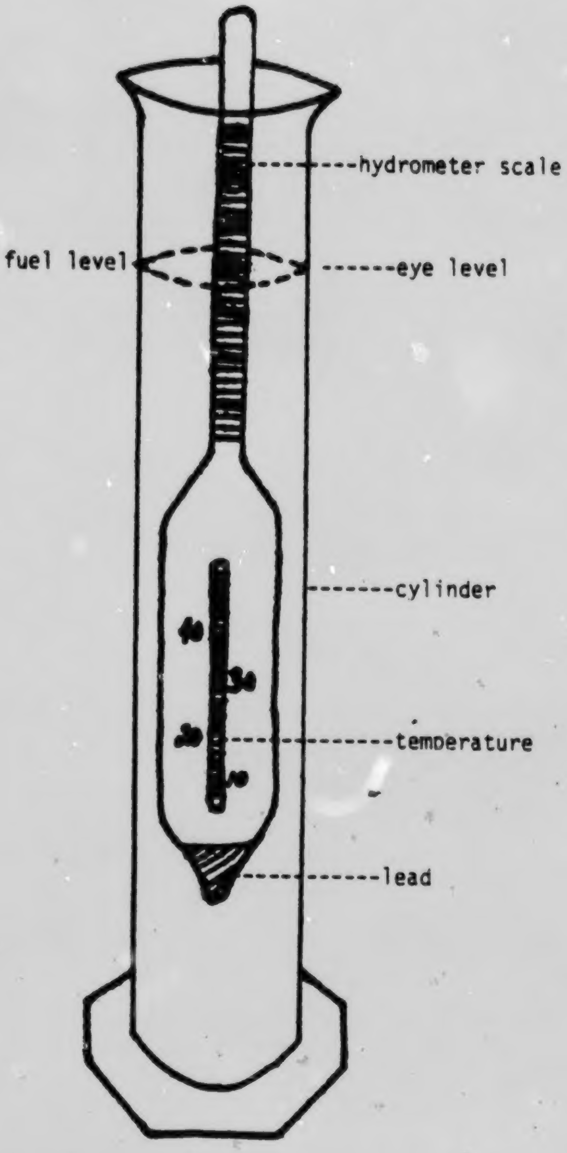

hydrometer scale
fuel level
eye level
cylinder
40
30
20
10
temperature
lead

Figure 2

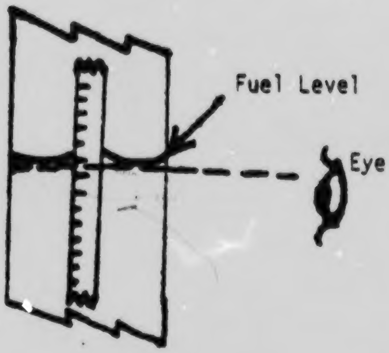

Fuel Level
Eye

Figure 3

TABLE 5

REDUCTION OF OBSERVED API GRAVITY TO API GRAVITY AT 60°F

This table gives the values of API gravity at 60°F corresponding to API gravities observed with a glass hydrometer at temperatures other than 60°F. The expression "API Gravity at Observed Temperature" appear in Table 5 since it is the term most generally used in industry. A more exact expression would be "API hydrometer indication at the observed temperature." The API hydrometer indication at temperature t°F differs slightly from the true API gravity because of the change in volume of the glass hydrometer from that at the calibration temperature 60°F.

It is generally impracticable to determine an API gravity at exactly 60°F, although it is at this temperature only that strictly correct results are obtained with a standard soft glass hydrometer calibrated at 60°F. In converting an API gravity at the observed temperature t°F (API hydrometer indication) to the corresponding API gravity at 60°F, two corrections are necessary: the first arises from the change in volume of the glass hydrometer with temperature, and the second from the change in volume of the oil. Both have been applied in this table.

This table must be enter with API gravities (hydrometer indications) measured with a soft glass hydrometer calibrated at 60°F.

EXAMPLE NO. 1

If the API gravity reading observed on a hydrometer in an oil at 76°F is 38.4°, what is its API gravity at 60°F?

Enter the table in the column "API Gravity at Observed Temperature," headed 38°API, and note that against an "Observed Temperature" of 76°F the corresponding API gravity at 60°F is. . . . . 36.8°API

Likewise, note that for 39°API at 76°F the corresponding API gravity at 60°F is . . . . 37.8°API

This represents an increase of 1.0°API at 60°F for an increase of 1.0°API in the value at 76°F. Therefore, by simple proportion, an increase at 76°F from 38 to 38.4°API increases the corresponding API gravity at 60°F by 0.4 X 1.0 or . . . . .0.4°API

Then, the API gravity at 60°F corresponding to the observed API gravity of 38.4 at 76°F is 36.8 + 0.4 or . . . . 37.2°API

Table 5

API Gravity Reduction to 60° F.

10-19° API

0-50° F.

Observed Temperature, °F.	API Gravity at Observed Temperature									
	10	11	12	13	14	15	16	17	18	19
	Corresponding API Gravity at 60° F.									
0	13.1	14.2	15.2	16.3	17.3	18.3	19.4	20.4	21.5	22.6
1	13.1	14.1	15.2	16.2	17.2	18.3	19.3	20.4	21.4	22.5
2	13.0	14.1	15.1	16.1	17.2	18.2	19.3	20.3	21.4	22.4
3	13.0	14.0	15.0	16.1	17.1	18.2	19.2	20.3	21.3	22.4
4	12.9	13.9	15.0	16.0	17.1	18.1	19.2	20.2	21.2	22.3
5	12.8	13.9	14.9	16.0	17.0	18.1	19.1	20.1	21.2	22.2
6	12.8	13.8	14.9	15.9	17.0	18.0	19.0	20.1	21.1	22.2
7	12.7	13.8	14.8	15.9	16.9	17.9	19.0	20.0	21.1	22.1
8	12.7	13.7	14.8	15.8	16.8	17.9	18.9	20.0	21.0	22.0
9	12.6	13.7	14.7	15.7	16.8	17.8	18.9	19.9	20.9	22.0
10	12.6	13.6	14.7	15.7	16.7	17.8	18.8	19.8	20.9	21.9
11	12.5	13.6	14.6	15.6	16.7	17.7	18.8	19.8	20.8	21.9
12	12.5	13.5	14.5	15.6	16.6	17.7	18.7	19.7	20.8	21.8
13	12.4	13.5	14.5	15.5	16.6	17.6	18.6	19.7	20.7	21.7
14	12.4	13.4	14.4	15.5	16.5	17.5	18.6	19.6	20.7	21.7
15	12.3	13.3	14.4	15.4	16.5	17.5	18.5	19.6	20.6	21.6
16	12.3	13.3	14.3	15.4	16.4	17.4	18.5	19.5	20.5	21.6
17	12.2	13.2	14.3	15.3	16.3	17.4	18.4	19.4	20.5	21.5
18	12.2	13.2	14.2	15.3	16.3	17.3	18.3	19.4	20.4	21.4
19	12.1	13.1	14.2	15.2	16.2	17.3	18.3	19.3	20.4	21.4
20	12.0	13.1	14.1	15.1	16.2	17.2	18.2	19.3	20.3	21.3
21	12.0	13.0	14.1	15.1	16.1	17.1	18.2	19.2	20.2	21.3
22	11.9	13.0	14.0	15.0	16.1	17.1	18.1	19.1	20.2	21.2
23	11.9	12.9	13.9	15.0	16.0	17.0	18.1	19.1	20.1	21.1
24	11.8	12.9	13.9	14.9	15.9	17.0	18.0	19.0	20.1	21.1
25	11.8	12.8	13.8	14.9	15.9	16.9	17.9	19.0	20.0	21.0
26	11.7	12.8	13.8	14.8	15.8	16.9	17.9	18.9	19.9	21.0
27	11.7	12.7	13.7	14.8	15.8	16.8	17.8	18.9	19.9	20.9
28	11.6	12.7	13.7	14.7	15.7	16.8	17.8	18.8	19.8	20.9
29	11.6	12.6	13.6	14.6	15.7	16.7	17.7	18.7	19.8	20.8
30	11.5	12.5	13.6	14.6	15.6	16.6	17.7	18.7	19.7	20.7
31	11.5	12.5	13.5	14.5	15.6	16.6	17.6	18.6	19.7	20.7
32	11.4	12.4	13.5	14.5	15.5	16.5	17.6	18.6	19.6	20.6
33	11.4	12.4	13.4	14.4	15.5	16.5	17.5	18.5	19.5	20.6
34	11.3	12.3	13.4	14.4	15.4	16.4	17.4	18.5	19.5	20.5
35	11.3	12.3	13.3	14.3	15.3	16.4	17.4	18.4	19.4	20.4
36	11.2	12.2	13.3	14.3	15.3	16.3	17.3	18.3	19.4	20.4
37	11.2	12.2	13.2	14.2	15.2	16.3	17.3	18.3	19.3	20.3
38	11.1	12.1	13.1	14.2	15.2	16.2	17.2	18.2	19.2	20.3
39	11.1	12.1	13.1	14.1	15.1	16.1	17.2	18.2	19.2	20.2
40	11.0	12.0	13.0	14.1	15.1	16.1	17.1	18.1	19.1	20.1
41	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.1	19.1	20.1
42	10.9	11.9	12.9	13.9	15.0	16.0	17.0	18.0	19.0	20.0
43	10.9	11.9	12.9	13.9	14.9	15.9	16.9	17.9	19.0	20.0
44	10.8	11.8	12.8	13.8	14.9	15.9	16.9	17.9	18.9	19.9
45	10.8	11.8	12.8	13.8	14.8	15.8	16.8	17.8	18.8	19.9
46	10.7	11.7	12.7	13.7	14.7	15.8	16.8	17.8	18.8	19.8
47	10.7	11.7	12.7	13.7	14.7	15.7	16.7	17.7	18.7	19.7
48	10.6	11.6	12.6	13.6	14.6	15.6	16.7	17.7	18.7	19.7
49	10.6	11.6	12.6	13.6	14.6	15.6	16.6	17.6	18.6	19.6
50	10.5	11.5	12.5	13.5	14.5	15.5	16.5	17.6	18.6	19.6

Table 5

10–19° API
50–100° F

API Gravity Reduction to 60° F.

Observed Temperature, °F.	API Gravity at Observed Temperature: 10	11	12	13	14	15	16	17	18	19
	Corresponding API Gravity at 60° F.									
50	10.5	11.5	12.5	13.5	14.5	15.5	16.5	17.6	18.6	19.6
51	10.5	11.5	12.5	13.5	14.5	15.5	16.5	17.5	18.5	19.5
52	10.4	11.4	12.4	13.4	14.4	15.4	16.4	17.4	18.5	19.5
53	10.4	11.4	12.4	13.4	14.4	15.4	16.4	17.4	18.4	19.4
54	10.3	11.3	12.3	13.3	14.3	15.3	16.3	17.3	18.3	19.3
55	10.2	11.3	12.3	13.3	14.3	15.3	16.3	17.3	18.3	19.3
56	10.2	11.2	12.2	13.2	14.2	15.2	16.2	17.2	18.2	19.2
57	10.1	11.2	12.2	13.2	14.2	15.2	16.2	17.2	18.2	19.2
58	10.1	11.1	12.1	13.1	14.1	15.1	16.1	17.1	18.1	19.1
59	10.0	11.1	12.1	13.1	14.1	15.1	16.1	17.1	18.1	19.1
60	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0
61	10.0	10.9	11.9	12.9	13.9	14.9	16.0	16.9	17.9	18.9
62	9.9	10.8	11.9	12.9	13.9	14.9	15.9	16.9	17.9	18.9
63	9.9	10.8	11.8	12.8	13.8	14.8	15.8	16.8	17.8	18.8
64	9.8	10.8	11.8	12.8	13.8	14.8	15.8	16.8	17.8	18.8
65	9.8	10.7	11.7	12.7	13.7	14.7	15.7	16.7	17.7	18.7
66	9.7	10.7	11.7	12.7	13.7	14.7	15.7	16.7	17.7	18.7
67	9.7	10.6	11.6	12.6	13.6	14.6	15.6	16.6	17.6	18.6
68	9.6	10.6	11.6	12.6	13.6	14.6	15.6	16.6	17.6	18.5
69	9.6	10.6	11.5	12.5	13.5	14.5	15.5	16.5	17.5	18.5
70	9.5	10.5	11.5	12.5	13.5	14.5	15.5	16.5	17.4	18.4
71	9.5	10.4	11.4	12.4	13.4	14.4	15.4	16.4	17.4	18.4
72	9.4	10.4	11.4	12.4	13.4	14.4	15.4	16.3	17.3	18.3
73	9.4	10.3	11.3	12.3	13.3	14.3	15.3	16.3	17.3	18.3
74	9.3	10.3	11.3	12.3	13.3	14.3	15.2	16.2	17.2	18.2
75	9.3	10.2	11.2	12.2	13.2	14.2	15.2	16.2	17.2	18.2
76	9.2	10.2	11.2	12.2	13.2	14.2	15.1	16.1	17.1	18.1
77	9.2	10.2	11.1	12.1	13.1	14.1	15.1	16.1	17.1	18.0
78	9.1	10.1	11.1	12.1	13.1	14.0	15.0	16.0	17.0	18.0
79	9.1	10.1	11.0	12.0	13.0	14.0	15.0	16.0	17.0	17.9
80	9.0	10.0	11.0	12.0	13.0	13.9	14.9	15.9	16.9	17.9
81	9.0	10.0	10.9	11.9	12.9	13.9	14.9	15.9	16.8	17.8
82	8.9	9.9	10.9	11.9	12.9	13.8	14.8	15.8	16.8	17.8
83	8.9	9.9	10.8	11.8	12.8	13.8	14.8	15.8	16.7	17.7
84	8.8	9.8	10.8	11.8	12.8	13.7	14.7	15.7	16.7	17.7
85	8.8	9.8	10.7	11.7	12.7	13.7	14.7	15.6	16.6	17.6
86	8.7	9.7	10.7	11.7	12.7	13.6	14.6	15.6	16.6	17.5
87	8.7	9.7	10.6	11.6	12.6	13.6	14.6	15.5	16.5	17.5
88	8.6	9.6	10.6	11.6	12.5	13.5	14.5	15.5	16.5	17.4
89	8.6	9.6	10.5	11.5	12.5	13.5	14.5	15.4	16.4	17.4
90	8.5	9.5	10.5	11.5	12.4	13.4	14.4	15.4	16.4	17.3
91	8.5	9.5	10.4	11.4	12.4	13.4	14.3	15.3	16.3	17.3
92	8.4	9.4	10.4	11.4	12.3	13.3	14.3	15.3	16.2	17.2
93	8.4	9.4	10.3	11.3	12.3	13.3	14.2	15.2	16.2	17.2
94	8.4	9.3	10.3	11.3	12.2	13.2	14.2	15.2	16.1	17.1
95	8.3	9.3	10.2	11.2	12.2	13.2	14.1	15.1	16.1	17.1
96	8.3	9.2	10.2	11.2	12.1	13.1	14.1	15.1	16.0	17.0
97	8.2	9.2	10.2	11.1	12.1	13.1	14.0	15.0	16.0	17.0
98	8.2	9.1	10.1	11.1	12.0	13.0	14.0	15.0	15.9	16.9
99	8.1	9.1	10.1	11.0	12.0	13.0	13.9	14.9	15.9	16.8
100	8.1	9.0	10.0	11.0	11.9	12.9	13.9	14.9	15.8	16.8

Table 5

20-29° API API Gravity Reduction to 60° F.

0-50° F.

Observed Temperature, °F.	API Gravity at Observed Temperature									
	20	21	22	23	24	25	26	27	28	29
	Corresponding API Gravity at 60° F.									
0	23.6	24.6	25.7	26.7	27.8	28.9	30.0	31.0	32.0	33.1
1	23.5	24.6	25.6	26.7	27.7	28.8	29.9	30.9	32.0	33.0
2	23.5	24.5	25.6	26.6	27.7	28.7	29.8	30.8	31.9	33.0
3	23.4	24.4	25.5	26.5	27.6	28.7	29.7	30.8	31.8	32.9
4	23.3	24.4	25.4	26.5	27.5	28.6	29.6	30.7	31.8	32.8
5	23.3	24.3	25.4	26.4	27.5	28.5	29.6	30.6	31.7	32.8
6	23.2	24.3	25.3	26.4	27.4	28.5	29.5	30.6	31.6	32.7
7	23.2	24.2	25.2	26.3	27.3	28.4	29.4	30.5	31.6	32.6
8	23.1	24.1	25.2	26.2	27.3	28.3	29.4	30.4	31.5	32.5
9	23.0	24.1	25.1	26.2	27.2	28.3	29.3	30.4	31.4	32.5
10	23.0	24.0	25.0	26.1	27.1	28.2	29.2	30.3	31.3	32.4
11	22.9	23.9	25.0	26.0	27.1	28.1	29.2	30.2	31.3	32.3
12	22.8	23.9	24.9	26.0	27.0	28.1	29.1	30.2	31.2	32.3
13	22.8	23.8	24.9	25.9	26.9	28.0	29.0	30.1	31.1	32.2
14	22.7	23.8	24.8	25.8	26.9	27.9	29.0	30.0	31.1	32.1
15	22.7	23.7	24.7	25.8	26.8	27.9	28.9	30.0	31.0	32.1
16	22.6	23.6	24.7	25.7	26.8	27.8	28.8	29.9	30.9	32.0
17	22.5	23.6	24.6	25.6	26.7	27.7	28.8	29.8	30.9	31.9
18	22.5	23.5	24.5	25.6	26.6	27.7	28.7	29.7	30.8	31.8
19	22.4	23.5	24.5	25.5	26.6	27.6	28.6	29.7	30.7	31.8
20	22.4	23.4	24.4	25.5	26.5	27.5	28.6	29.6	30.7	31.7
21	22.3	23.3	24.4	25.4	26.4	27.5	28.5	29.5	30.6	31.6
22	22.2	23.3	24.3	25.3	26.4	27.4	28.4	29.5	30.5	31.6
23	22.2	23.2	24.2	25.3	26.3	27.3	28.4	29.4	30.5	31.5
24	22.1	23.1	24.2	25.2	26.2	27.3	28.3	29.3	30.4	31.4
25	22.1	23.1	24.1	25.1	26.2	27.2	28.2	29.3	30.3	31.4
26	22.0	23.0	24.1	25.1	26.1	27.1	28.2	29.2	30.2	31.3
27	21.9	23.0	24.0	25.0	26.0	27.1	28.1	29.1	30.2	31.2
28	21.9	22.9	23.9	25.0	26.0	27.0	28.0	29.1	30.1	31.1
29	21.8	22.8	23.9	24.9	25.9	27.0	28.0	29.0	30.0	31.1
30	21.8	22.8	23.8	24.8	25.9	26.9	27.9	28.9	30.0	31.0
31	21.7	22.7	23.7	24.8	25.8	26.8	27.9	28.9	29.9	30.9
32	21.6	22.7	23.7	24.7	25.7	26.8	27.8	28.8	29.8	30.9
33	21.6	22.6	23.6	24.6	25.7	26.7	27.7	28.7	29.8	30.8
34	21.5	22.5	23.6	24.6	25.6	26.6	27.7	28.7	29.7	30.7
35	21.5	22.5	23.5	24.5	25.5	26.6	27.6	28.6	29.6	30.7
36	21.4	22.4	23.4	24.5	25.5	26.5	27.5	28.6	29.6	30.6
37	21.3	22.4	23.4	24.4	25.4	26.4	27.5	28.5	29.5	30.5
38	21.3	22.3	23.3	24.3	25.4	26.4	27.4	28.4	29.4	30.5
39	21.2	22.2	23.3	24.3	25.3	26.3	27.3	28.4	29.4	30.4
40	21.2	22.2	23.2	24.2	25.2	26.2	27.3	28.3	29.3	30.3
41	21.1	22.1	23.1	24.2	25.2	26.2	27.2	28.2	29.2	30.3
42	21.0	22.1	23.1	24.1	25.1	26.1	27.1	28.2	29.2	30.2
43	21.0	22.0	23.0	24.0	25.0	26.1	27.1	28.1	29.1	30.1
44	20.9	21.9	23.0	24.0	25.0	26.0	27.0	28.0	29.0	30.1
45	20.9	21.9	22.9	23.9	24.9	25.9	26.9	28.0	29.0	30.0
46	20.8	21.8	22.8	23.8	24.9	25.9	26.9	27.9	28.9	29.9
47	20.8	21.8	22.8	23.8	24.8	25.8	26.8	27.8	28.8	29.9
48	20.7	21.7	22.7	23.7	24.7	25.7	26.8	27.8	28.8	29.8
49	20.6	21.6	22.7	23.7	24.7	25.7	26.7	27.7	28.7	29.7
50	20.6	21.6	22.6	23.6	24.6	25.6	26.6	27.6	28.6	29.7

119

Table 5

API Gravity Reduction to 60° F.

20-29° API

50-100° F.

Observed Temperature, °F.	API Gravity at Observed Temperature									
	20	21	22	23	24	25	26	27	28	29
	Corresponding API Gravity at 60° F.									
50	20.6	21.6	22.6	23.6	24.6	25.6	26.6	27.6	28.6	29.7
51	20.5	21.5	22.5	23.5	24.6	25.6	26.6	27.6	28.6	29.6
52	20.5	21.5	22.5	23.5	24.5	25.5	26.5	27.5	28.5	29.5
53	20.4	21.4	22.4	23.4	24.4	25.4	26.4	27.4	28.5	29.5
54	20.3	21.4	22.4	23.4	24.4	25.4	26.4	27.4	28.4	29.4
55	20.3	21.3	22.3	23.3	24.3	25.3	26.3	27.3	28.3	29.3
56	20.2	21.2	22.2	23.2	24.2	25.2	26.3	27.3	28.3	29.3
57	20.2	21.2	22.2	23.2	24.2	25.2	26.2	27.2	28.2	29.2
58	20.1	21.1	22.1	23.1	24.1	25.1	26.1	27.1	28.1	29.1
59	20.1	21.1	22.1	23.1	24.1	25.1	26.1	27.1	28.1	29.1
60	20.0	21.0	22.0	23.0	24.0	25.0	26.0	27.0	28.0	29.0
61	20.0	21.0	21.9	22.9	23.9	24.9	25.9	26.9	27.9	28.9
62	19.9	20.9	21.9	22.9	23.9	24.9	25.9	26.9	27.9	28.9
63	19.8	20.8	21.8	22.8	23.8	24.8	25.8	26.8	27.8	28.8
64	19.8	20.8	21.8	22.8	23.8	24.8	25.8	26.7	27.7	28.7
65	19.7	20.7	21.7	22.7	23.7	24.7	25.7	26.7	27.7	28.7
66	19.7	20.7	21.6	22.6	23.6	24.6	25.6	26.6	27.6	28.6
67	19.6	20.6	21.6	22.6	23.6	24.6	25.6	26.6	27.6	28.5
68	19.5	20.5	21.5	22.5	23.5	24.5	25.5	26.5	27.5	28.5
69	19.5	20.5	21.5	22.5	23.5	24.4	25.4	26.4	27.4	28.4
70	19.4	20.4	21.4	22.4	23.4	24.4	25.4	26.4	27.4	28.3
71	19.4	20.4	21.4	22.3	23.3	24.3	25.3	26.3	27.3	28.3
72	19.3	20.3	21.3	22.3	23.3	24.3	25.3	26.2	27.2	28.2
73	19.3	20.2	21.2	22.2	23.2	24.2	25.2	26.2	27.2	28.2
74	19.2	20.2	21.2	22.2	23.2	24.1	25.1	26.1	27.1	28.1
75	19.1	20.1	21.1	22.1	23.1	24.1	25.1	26.1	27.0	28.0
76	19.1	20.1	21.1	22.0	23.0	24.0	25.0	26.0	27.0	28.0
77	19.0	20.0	21.0	22.0	23.0	24.0	24.9	25.9	26.9	27.9
78	19.0	20.0	20.9	21.9	22.9	23.9	24.9	25.9	26.9	27.8
79	18.9	19.9	20.9	21.9	22.9	23.8	24.8	25.8	26.8	27.8
80	18.9	19.8	20.8	21.8	22.8	23.8	24.8	25.7	26.7	27.7
81	18.8	19.8	20.8	21.8	22.7	23.7	24.7	25.7	26.7	27.6
82	18.8	19.7	20.7	21.7	22.7	23.7	24.6	25.6	26.6	27.6
83	18.7	19.7	20.7	21.6	22.6	23.6	24.6	25.6	26.5	27.5
84	18.6	19.6	20.6	21.6	22.6	23.5	24.5	25.5	26.5	27.5
85	18.6	19.6	20.5	21.5	22.5	23.5	24.5	25.4	26.4	27.4
86	18.5	19.5	20.5	21.5	22.4	23.4	24.4	25.4	26.4	27.3
87	18.5	19.5	20.4	21.4	22.4	23.4	24.3	25.3	26.3	27.3
88	18.4	19.4	20.4	21.3	22.3	23.3	24.3	25.3	26.2	27.2
89	18.4	19.3	20.3	21.3	22.3	23.2	24.2	25.2	26.2	27.1
90	18.3	19.3	20.3	21.2	22.2	23.2	24.2	25.1	26.1	27.1
91	18.3	19.2	20.2	21.2	22.2	23.1	24.1	25.1	26.0	27.0
92	18.2	19.2	20.1	21.1	22.1	23.1	24.0	25.0	26.0	27.0
93	18.1	19.1	20.1	21.1	22.0	23.0	24.0	25.0	25.9	26.9
94	18.1	19.1	20.0	21.0	22.0	22.9	23.9	24.9	25.9	26.8
95	18.0	19.0	20.0	20.9	21.9	22.9	23.9	24.8	25.8	26.8
96	18.0	18.9	19.9	20.9	21.9	22.8	23.8	24.8	25.7	26.7
97	17.9	18.9	19.9	20.8	21.8	22.8	23.7	24.7	25.7	26.6
98	17.9	18.8	19.8	20.8	21.7	22.7	23.7	24.7	25.6	26.6
99	17.8	18.8	19.7	20.7	21.7	22.7	23.6	24.6	25.6	26.5
100	17.8	18.7	19.7	20.7	21.6	22.6	23.6	24.5	25.5	26.5

120

Table 5

API Gravity Reduction to 60° F.

30-39° API

0-50° F.

Observed Temperature, °F.	API Gravity at Observed Temperature									
	30	31	32	33	34	35	36	37	38	39
	Corresponding API Gravity at 60° F.									
0	34.2	35.3	36.3	37.4	38.5	39.6	40.7	41.8	42.9	44.0
1	34.1	35.2	36.3	37.3	38.4	39.5	40.6	41.7	42.8	43.9
2	34.0	35.1	36.2	37.3	38.3	39.4	40.5	41.5	42.7	43.8
3	34.0	35.0	36.1	37.2	38.3	39.3	40.4	41.5	42.6	43.7
4	33.9	35.0	36.0	37.1	38.2	39.3	40.3	41.4	42.5	43.6
5	33.8	34.9	36.0	37.0	38.1	39.2	40.3	41.3	42.4	43.5
6	33.7	34.8	35.9	36.9	38.0	39.1	40.2	41.3	42.3	43.4
7	33.7	34.7	35.8	36.9	37.9	39.0	40.1	41.2	42.3	43.3
8	33.6	34.7	35.7	36.8	37.9	38.9	40.0	41.1	42.2	43.3
9	33.5	34.6	35.7	36.7	37.8	38.9	39.9	41.0	42.1	43.2
10	33.5	34.5	35.6	36.6	37.7	38.8	39.8	40.9	42.0	43.1
11	33.4	34.4	35.5	36.6	37.6	38.7	39.8	40.8	41.9	43.0
12	33.3	34.4	35.4	36.5	37.6	38.6	39.7	40.8	41.8	42.9
13	33.2	34.3	35.4	36.4	37.5	38.5	39.6	40.7	41.7	42.8
14	33.2	34.2	35.3	36.3	37.4	38.5	39.5	40.6	41.7	42.7
15	33.1	34.2	35.2	36.3	37.3	38.4	39.4	40.5	41.6	42.7
16	33.0	34.1	35.1	36.2	37.2	38.3	39.4	40.4	41.5	42.6
17	33.0	34.0	35.1	36.1	37.2	38.2	39.3	40.4	41.4	42.5
18	32.9	33.9	35.0	36.0	37.1	38.1	39.2	40.3	41.3	42.4
19	32.8	33.9	34.9	36.0	37.0	38.1	39.1	40.2	41.2	42.3
20	32.7	33.8	34.8	35.9	36.9	38.0	39.0	40.1	41.2	42.2
21	32.7	33.7	34.8	35.8	36.9	37.9	39.0	40.0	41.1	42.1
22	32.6	33.6	34.7	35.7	36.8	37.8	38.9	39.9	41.0	42.1
23	32.5	33.6	34.6	35.7	36.7	37.8	38.8	39.9	40.9	42.0
24	32.5	33.5	34.5	35.6	36.6	37.7	38.7	39.8	40.8	41.9
25	32.4	33.4	34.5	35.5	36.6	37.6	38.7	39.7	40.8	41.8
26	32.3	33.4	34.4	35.4	36.5	37.5	38.6	39.6	40.7	41.7
27	32.3	33.3	34.3	35.4	36.4	37.5	38.5	39.5	40.6	41.6
28	32.2	33.2	34.3	35.3	36.3	37.4	38.4	39.5	40.5	41.6
29	32.1	33.1	34.2	35.2	36.3	37.3	38.3	39.4	40.4	41.5
30	32.0	33.1	34.1	35.1	36.2	37.2	38.3	39.3	40.4	41.4
31	32.0	33.0	34.0	35.1	36.1	37.1	38.2	39.2	40.3	41.3
32	31.9	32.9	34.0	35.0	36.0	37.1	38.1	39.1	40.2	41.2
33	31.8	32.9	33.9	34.9	36.0	37.0	38.0	39.1	40.1	41.1
34	31.8	32.8	33.8	34.9	35.9	36.9	38.0	39.0	40.0	41.1
35	31.7	32.7	33.8	34.8	35.8	36.8	37.9	38.9	39.9	41.0
36	31.6	32.7	33.7	34.7	35.7	36.8	37.8	38.8	39.9	40.9
37	31.6	32.6	33.6	34.6	35.7	36.7	37.7	38.8	39.8	40.8
38	31.5	32.5	33.5	34.6	35.6	36.6	37.6	38.7	39.7	40.7
39	31.4	32.4	33.5	34.5	35.5	36.5	37.6	38.6	39.6	40.7
40	31.4	32.4	33.4	34.4	35.4	36.5	37.5	38.5	39.6	40.6
41	31.3	32.3	33.3	34.3	35.4	36.4	37.4	38.4	39.5	40.5
42	31.2	32.2	33.3	34.3	35.3	36.3	37.3	38.4	39.4	40.4
43	31.1	32.2	33.2	34.2	35.2	36.2	37.3	38.3	39.3	40.3
44	31.1	32.1	33.1	34.1	35.2	36.2	37.2	38.2	39.2	40.3
45	31.0	32.0	33.0	34.1	35.1	36.1	37.1	38.1	39.2	40.2
46	30.9	32.0	33.0	34.0	35.0	36.0	37.0	38.1	39.1	40.1
47	30.9	31.9	32.9	33.9	34.9	35.9	37.0	38.0	39.0	40.0
48	30.8	31.8	32.8	33.8	34.9	35.9	36.9	37.9	38.9	39.9
49	30.7	31.7	32.8	33.8	34.8	35.8	36.8	37.8	38.8	39.9
50	30.7	31.7	32.7	33.7	34.7	35.7	36.7	37.8	38.8	39.8

121

Table 5

30–39° API **API Gravity Reduction to 60° F.**

50-100° F.

Observed Temperature, °F.	API Gravity at Observed Temperature									
	30	31	32	33	34	35	36	37	38	39
	Corresponding API Gravity at 60° F.									
50	30.7	31.7	32.7	33.7	34.7	35.7	36.7	37.8	38.8	39.8
51	30.6	31.6	32.6	33.6	34.6	35.7	36.7	37.7	38.7	39.7
52	30.5	31.5	32.6	33.6	34.6	35.6	36.6	37.6	38.6	39.6
53	30.5	31.5	32.5	33.5	34.5	35.5	36.5	37.5	38.5	39.5
54	30.4	31.4	32.4	33.4	34.4	35.4	36.4	37.5	38.5	39.5
55	30.3	31.3	32.3	33.4	34.4	35.4	36.4	37.4	38.4	39.4
56	30.3	31.3	32.3	33.3	34.3	35.3	36.3	37.3	38.3	39.3
57	30.2	31.2	32.2	33.2	34.2	35.2	36.2	37.2	38.2	39.2
58	30.1	31.1	32.1	33.1	34.1	35.1	36.1	37.1	38.2	39.2
59	30.1	31.1	32.1	33.1	34.1	35.1	36.1	37.1	38.1	39.1
60	30.0	31.0	32.0	33.0	34.0	35.0	36.0	37.0	38.0	39.0
61	29.9	30.9	31.9	32.9	33.9	34.9	35.9	36.9	37.9	38.9
62	29.9	30.9	31.9	32.9	33.9	34.9	35.9	36.9	37.8	38.8
63	29.8	30.8	31.8	32.8	33.8	34.8	35.8	36.8	37.8	38.8
64	29.7	30.7	31.7	32.7	33.7	34.7	35.7	36.7	37.7	38.7
65	29.7	30.7	31.7	32.7	33.6	34.6	35.6	36.6	37.6	38.6
66	29.6	30.6	31.6	32.6	33.6	34.6	35.6	36.6	37.5	38.5
67	29.5	30.5	31.6	32.5	33.5	34.5	35.5	36.5	37.5	38.5
68	29.5	30.5	31.5	32.4	33.4	34.4	35.4	36.4	37.4	38.4
69	29.4	30.4	31.4	32.4	33.4	34.4	35.3	36.3	37.3	38.3
70	29.3	30.3	31.3	32.3	33.3	34.3	35.3	36.3	37.2	38.2
71	29.3	30.3	31.3	32.2	33.2	34.2	35.2	36.2	37.2	38.2
72	29.2	30.2	31.2	32.2	33.2	34.1	35.1	36.1	37.1	38.1
73	29.1	30.1	31.1	32.1	33.1	34.1	35.1	36.0	37.0	38.0
74	29.1	30.1	31.0	32.0	33.0	34.0	35.0	36.0	36.9	37.9
75	29.0	30.0	31.0	32.0	32.9	33.9	34.9	35.9	36.9	37.9
76	28.9	29.9	30.9	31.9	32.9	33.9	34.8	35.8	36.8	37.8
77	28.9	29.9	30.8	31.8	32.8	33.8	34.8	35.7	36.7	37.7
78	28.8	29.8	30.8	31.8	32.7	33.7	34.7	35.7	36.7	37.6
79	28.8	29.7	30.7	31.7	32.7	33.7	34.6	35.6	36.6	37.6
80	28.7	29.7	30.6	31.6	32.6	33.6	34.6	35.5	36.5	37.5
81	28.6	29.6	30.6	31.6	32.5	33.5	34.5	35.5	36.4	37.4
82	28.6	29.5	30.5	31.5	32.5	33.4	34.4	35.4	36.4	37.3
83	28.5	29.5	30.4	31.4	32.4	33.4	34.3	35.3	36.3	37.3
84	28.4	29.4	30.4	31.4	32.3	33.3	34.3	35.2	36.2	37.2
85	28.4	29.3	30.3	31.3	32.3	33.2	34.2	35.2	36.1	37.1
86	28.3	29.3	30.3	31.2	32.2	33.2	34.1	35.1	36.1	37.0
87	28.2	29.2	30.2	31.2	32.1	33.1	34.1	35.0	36.0	37.0
88	28.2	29.1	30.1	31.1	32.1	33.0	34.0	35.0	35.9	36.9
89	28.1	29.1	30.1	31.0	32.0	33.0	33.9	34.9	35.9	36.8
90	28.0	29.0	30.0	31.0	31.9	32.9	33.9	34.8	35.8	36.7
91	28.0	29.0	29.9	30.9	31.9	32.8	33.8	34.7	35.7	36.7
92	27.9	28.9	29.9	30.8	31.8	32.8	33.7	34.7	35.6	36.6
93	27.9	28.8	29.8	30.8	31.7	32.7	33.7	34.6	35.6	36.5
94	27.8	28.8	29.7	30.7	31.7	32.6	33.6	34.5	35.5	36.5
95	27.7	28.7	29.7	30.6	31.6	32.5	33.5	34.5	35.4	36.4
96	27.7	28.6	29.6	30.6	31.5	32.5	33.4	34.4	35.4	36.3
97	27.6	28.6	29.5	30.5	31.5	32.4	33.4	34.3	35.3	36.2
98	27.5	28.5	29.5	30.4	31.4	32.3	33.3	34.3	35.2	36.2
99	27.5	28.4	29.4	30.4	31.3	32.3	33.2	34.2	35.1	36.1
100	27.4	28.4	29.3	30.3	31.3	32.2	33.2	34.1	35.1	36.0

Table 5

API Gravity Reduction to 60° F.

40–49° API

0-50° F.

Observed Temperature, °F.	API Gravity at Observed Temperature									
	40	41	42	43	44	45	46	47	48	49
	Corresponding API Gravity at 60° F.									
0	45.1	46.2	47.3	48.4	49.5	50.6	51.8	52.9	54.0	55.2
1	45.0	46.1	47.2	48.3	49.4	50.5	51.6	52.8	53.9	55.0
2	44.9	46.0	47.1	48.2	49.3	50.4	51.5	52.7	53.8	54.9
3	44.8	45.9	47.0	48.1	49.2	50.3	51.4	52.6	53.7	54.8
4	44.7	45.8	46.9	48.0	49.1	50.2	51.3	52.5	53.6	54.7
5	44.6	45.7	46.8	47.9	49.0	50.1	51.2	52.3	53.5	54.6
6	44.5	45.6	46.7	47.8	48.9	50.0	51.1	52.2	53.4	54.5
7	44.4	45.5	46.6	47.7	48.8	49.9	51.0	52.1	53.3	54.4
8	44.3	45.4	46.5	47.6	48.7	49.8	50.9	52.0	53.1	54.3
9	44.3	45.3	46.4	47.5	48.6	49.7	50.8	51.9	53.0	54.2
10	44.2	45.2	46.3	47.4	48.5	49.6	50.7	51.8	52.9	54.0
11	44.1	45.2	46.2	47.3	48.4	49.5	50.6	51.7	52.8	53.9
12	44.0	45.1	46.2	47.2	48.3	49.4	50.5	51.6	52.7	53.8
13	43.9	45.0	46.1	47.1	48.2	49.3	50.4	51.5	52.6	53.7
14	43.8	44.9	46.0	47.1	48.1	49.2	50.3	51.4	52.5	53.6
15	43.7	44.8	45.9	47.0	48.0	49.1	50.2	51.3	52.4	53.5
16	43.6	44.7	45.8	46.9	48.0	49.0	50.1	51.2	52.3	53.4
17	43.6	44.6	45.7	46.8	47.9	48.9	50.0	51.1	52.2	53.3
18	43.5	44.5	45.6	46.7	47.8	48.8	49.9	51.0	52.1	53.2
19	43.4	44.4	45.5	46.6	47.7	48.7	49.8	50.9	52.0	53.1
20	43.3	44.4	45.4	46.5	47.6	48.7	49.7	50.8	51.9	53.0
21	43.2	44.3	45.3	46.4	47.5	48.6	49.6	50.7	51.8	52.9
22	43.1	44.2	45.2	46.3	47.4	48.5	49.5	50.6	51.7	52.8
23	43.0	44.1	45.2	46.2	47.3	48.4	49.4	50.5	51.6	52.7
24	42.9	44.0	45.1	46.1	47.2	48.3	49.3	50.4	51.5	52.6
25	42.9	43.9	45.0	46.0	47.1	48.2	49.2	50.3	51.4	52.4
26	42.8	43.8	44.9	46.0	47.0	48.1	49.1	50.2	51.3	52.3
27	42.7	43.7	44.8	45.9	46.9	48.0	49.0	50.1	51.2	52.2
28	42.6	43.7	44.7	45.8	46.8	47.9	48.9	50.0	51.1	52.1
29	42.5	43.6	44.6	45.7	46.7	47.8	48.9	49.9	51.0	52.0
30	42.4	43.5	44.5	45.6	46.6	47.7	48.8	49.8	50.9	51.9
31	42.4	43.4	44.5	45.5	46.6	47.6	48.7	49.7	50.8	51.8
32	42.3	43.3	44.4	45.4	46.5	47.5	48.6	49.6	50.7	51.7
33	42.2	43.2	44.3	45.3	46.4	47.4	48.5	49.5	50.6	51.6
34	42.1	43.1	44.2	45.2	46.3	47.3	48.4	49.4	50.5	51.5
35	42.0	43.1	44.1	45.1	46.2	47.2	48.3	49.3	50.4	51.4
36	41.9	43.0	44.0	45.1	46.1	47.1	48.2	49.2	50.3	51.3
37	41.9	42.9	43.9	45.0	46.0	47.0	48.1	49.1	50.2	51.2
38	41.8	42.8	43.8	44.9	45.9	47.0	48.0	49.0	50.1	51.1
39	41.7	42.7	43.8	44.8	45.8	46.9	47.9	48.9	50.0	51.0
40	41.6	42.6	43.7	44.7	45.7	46.8	47.8	48.9	49.9	50.9
41	41.5	42.6	43.6	44.6	45.7	46.7	47.7	48.8	49.8	50.8
42	41.4	42.5	43.5	44.5	45.6	46.6	47.6	48.7	49.7	50.7
43	41.4	42.4	43.4	44.4	45.5	46.5	47.5	48.6	49.6	50.6
44	41.3	42.3	43.3	44.4	45.4	46.4	47.4	48.5	49.5	50.5
45	41.2	42.2	43.2	44.3	45.3	46.3	47.3	48.4	49.4	50.4
46	41.1	42.1	43.2	44.2	45.2	46.2	47.3	48.3	49.3	50.3
47	41.0	42.1	43.1	44.1	45.1	46.1	47.2	48.2	49.2	50.2
48	41.0	42.0	43.0	44.0	45.0	46.1	47.1	48.1	49.1	50.1
49	40.9	41.9	42.9	43.9	44.9	46.0	47.0	48.0	49.0	50.0
50	40.8	41.8	42.8	43.8	44.9	45.9	46.9	47.9	48.9	50.0

Table 5

40–49° API

50-100° F.

API Gravity Reduction to 60° F.

Observed Temperature, °F.	API Gravity at Observed Temperature									
	40	41	42	43	44	45	46	47	48	49
	Corresponding API Gravity at 60° F.									
50	40.8	41.8	42.8	43.8	44.9	45.9	46.9	47.9	48.9	50.0
51	40.7	41.7	42.7	43.8	44.8	45.8	46.8	47.8	48.8	49.9
52	40.6	41.6	42.7	43.7	44.7	45.7	46.7	47.7	48.7	49.8
53	40.6	41.6	42.6	43.6	44.6	45.6	46.6	47.6	48.6	49.7
54	40.5	41.5	42.5	43.5	44.5	45.5	46.5	47.5	48.5	49.6
55	40.4	41.4	42.4	43.4	44.4	45.4	46.4	47.5	48.5	49.5
56	40.3	41.3	42.3	43.3	44.3	45.3	46.4	47.4	48.4	49.4
57	40.2	41.2	42.2	43.3	44.3	45.3	46.3	47.3	48.3	49.3
58	40.2	41.2	42.2	43.2	44.2	45.2	46.2	47.2	48.2	49.2
59	40.1	41.1	42.1	43.1	44.1	45.1	46.1	47.1	48.1	49.1
60	40.0	41.0	42.0	43.0	44.0	45.0	46.0	47.0	48.0	49.0
61	39.9	40.9	41.9	42.9	43.9	44.9	45.9	46.9	47.9	48.9
62	39.8	40.8	41.8	42.8	43.8	44.8	45.8	46.8	47.8	48.8
63	39.8	40.8	41.8	42.8	43.7	44.7	45.7	46.7	47.7	48.7
64	39.7	40.7	41.7	42.7	43.7	44.7	45.6	46.6	47.6	48.6
65	39.6	40.6	41.6	42.6	43.6	44.6	45.6	46.6	47.5	48.5
66	39.5	40.5	41.5	42.5	43.5	44.5	45.5	46.5	47.5	48.4
67	39.5	40.4	41.4	42.4	43.4	44.4	45.4	46.4	47.4	48.3
68	39.4	40.4	41.4	42.3	43.3	44.3	45.3	46.3	47.3	48.3
69	39.3	40.3	41.3	42.3	43.2	44.2	45.2	46.2	47.2	48.2
70	39.2	40.2	41.2	42.2	43.2	44.1	45.1	46.1	47.1	48.1
71	39.1	40.1	41.1	42.1	43.1	44.1	45.0	46.0	47.0	48.0
72	39.1	40.0	41.0	42.0	43.0	44.0	45.0	45.9	46.9	47.9
73	39.0	40.0	41.0	41.9	42.9	43.9	44.9	45.8	46.8	47.8
74	38.9	39.9	40.9	41.9	42.8	43.8	44.8	45.8	46.7	47.7
75	38.8	39.8	40.8	41.8	42.7	43.7	44.7	45.7	46.6	47.6
76	38.8	39.7	40.7	41.7	42.7	43.6	44.6	45.6	46.6	47.5
77	38.7	39.7	40.6	41.6	42.6	43.6	44.5	45.5	46.5	47.4
78	38.6	39.6	40.6	41.5	42.5	43.5	44.4	45.4	46.4	47.4
79	38.5	39.5	40.5	41.4	42.4	43.4	44.4	45.3	46.3	47.3
80	38.5	39.4	40.4	41.4	42.3	43.3	44.3	45.2	46.2	47.2
81	38.4	39.4	40.3	41.3	42.3	43.2	44.2	45.2	46.1	47.1
82	38.3	39.3	40.2	41.2	42.2	43.1	44.1	45.1	46.0	47.0
83	38.2	39.2	40.2	41.1	42.1	43.1	44.0	45.0	45.9	46.9
84	38.2	39.1	40.1	41.1	42.0	43.0	43.9	44.9	45.9	46.8
85	38.1	39.0	40.0	41.0	41.9	42.9	43.9	44.8	45.8	46.7
86	38.0	39.0	39.9	40.9	41.9	42.8	43.8	44.7	45.7	46.6
87	37.9	38.9	39.9	40.8	41.8	42.7	43.7	44.6	45.6	46.6
88	37.9	38.8	39.8	40.7	41.7	42.7	43.6	44.6	45.5	46.5
89	37.8	38.7	39.7	40.7	41.6	42.6	43.5	44.5	45.4	46.4
90	37.7	38.7	39.6	40.6	41.5	42.5	43.4	44.4	45.3	46.3
91	37.6	38.6	39.5	40.5	41.5	42.4	43.4	44.3	45.3	46.2
92	37.6	38.5	39.5	40.4	41.4	42.3	43.3	44.2	45.2	46.1
93	37.5	38.4	39.4	40.3	41.3	42.2	43.2	44.1	45.1	46.0
94	37.4	38.4	39.3	40.3	41.2	42.2	43.1	44.1	45.0	45.9
95	37.3	38.3	39.2	40.2	41.1	42.1	43.0	44.0	44.9	45.9
96	37.3	38.2	39.2	40.1	41.1	42.0	43.0	43.9	44.8	45.8
97	37.2	38.1	39.1	40.0	41.0	41.9	42.9	43.8	44.8	45.7
98	37.1	38.1	39.0	40.0	40.9	41.8	42.8	43.7	44.7	45.6
99	37.0	38.0	38.9	39.9	40.8	41.8	42.7	43.6	44.6	45.5
100	37.0	37.9	38.9	39.8	40.7	41.7	42.6	43.6	44.5	45.4

124

Table 5

API Gravity Reduction to 60° F.

50–59° API

0–50° F.

Observed Temperature, °F.	API Gravity at Observed Temperature									
	50	51	52	53	54	55	56	57	58	59
	Corresponding API Gravity at 60° F.									
0	56.3	57.4	58.5	59.7	60.8	61.9	63.0	64.2	65.3	66.4
1	56.2	57.3	58.4	59.5	60.7	61.8	62.9	64.0	65.2	66.3
2	56.1	57.2	58.3	59.4	60.5	61.7	62.8	63.9	65.0	66.1
3	56.0	57.1	58.2	59.3	60.4	61.5	62.7	63.8	64.9	66.0
4	55.8	57.0	58.1	59.2	60.3	61.4	62.5	63.6	64.8	65.9
5	55.7	56.9	58.0	59.1	60.2	61.3	62.4	63.5	64.6	65.8
6	55.6	56.7	57.8	59.0	60.1	61.2	62.3	63.4	64.5	65.6
7	55.5	56.6	57.7	58.8	59.9	61.0	62.2	63.3	64.4	65.5
8	55.4	56.5	57.6	58.7	59.8	60.9	62.0	63.1	64.3	65.[illegible]
9	55.3	56.4	57.5	58.6	59.7	60.8	61.9	63.0	64.1	65.2
10	55.2	56.3	57.4	58.5	59.6	60.7	61.8	62.9	64.0	65.1
11	55.1	56.2	57.3	58.4	59.5	60.6	61.7	62.8	63.9	65.0
12	54.9	56.1	57.2	58.3	59.3	60.4	61.5	62.6	63.7	64.8
13	54.8	55.9	57.0	58.1	59.2	60.3	61.4	62.5	63.6	64.7
14	54.7	55.8	56.9	58.0	59.1	60.2	61.3	62.4	63.5	64.6
15	54.6	55.7	56.8	57.9	59.0	60.1	61.2	62.3	63.4	64.5
16	54.5	55.6	56.7	57.8	58.9	60.0	61.1	62.1	63.2	64.3
17	54.4	55.5	56.6	57.7	58.8	59.8	60.9	62.0	63.1	64.2
18	54.3	55.4	56.5	57.6	58.6	59.7	60.8	61.9	63.0	64.1
19	54.2	55.3	56.4	57.4	58.5	59.6	60.7	61.8	62.9	63.9
20	54.1	55.2	56.2	57.3	58.4	59.5	60.6	61.7	62.7	63.8
21	54.0	55.0	56.1	57.2	58.3	59.4	60.5	61.5	62.6	63.7
22	53.8	54.9	56.0	57.1	58.2	59.3	60.3	61.4	62.5	63.6
23	53.7	54.8	55.9	57.0	58.1	59.1	60.2	61.3	62.4	63.4
24	53.6	54.7	55.8	56.9	57.9	59.0	60.1	61.2	62.2	63.3
25	53.5	54.6	55.7	56.8	57.8	58.9	60.0	61.0	62.1	63.2
26	53.4	54.5	55.6	56.7	57.7	58.8	59.9	60.9	62.0	63.1
27	53.3	54.4	55.5	56.5	57.6	58.7	59.7	60.8	61.9	62.9
28	53.2	54.3	55.4	56.4	57.5	58.6	59.6	60.7	61.7	62.8
29	53.1	54.2	55.2	56.3	57.4	58.4	59.5	60.6	61.6	62.7
30	53.0	54.1	55.1	56.2	57.3	58.3	59.4	60.4	61.5	62.6
31	52.9	54.0	55.0	56.1	57.2	58.2	59.3	60.3	61.4	62.4
32	52.8	53.9	54.9	56.0	57.0	58.1	59.2	60.2	61.3	62.3
33	52.7	53.7	54.8	55.9	56.9	58.0	59.0	60.1	61.1	62.2
34	52.6	53.6	54.7	55.8	56.8	57.9	58.9	60.0	61.0	62.1
35	52.5	53.5	54.6	55.6	56.7	57.8	58.8	59.9	60.9	62.0
36	52.4	53.4	54.5	55.5	56.6	57.6	58.7	59.7	60.8	61.8
37	52.3	53.3	54.4	55.4	56.5	57.5	58.6	59.6	60.7	61.7
38	52.2	53.2	54.3	55.3	56.4	57.4	58.5	59.5	60.5	61.6
39	52.1	53.1	54.2	55.2	56.3	57.3	58.3	59.4	60.4	61.5
40	52.0	53.0	54.1	55.1	56.1	57.2	58.2	59.3	60.3	61.3
41	51.9	52.9	54.0	55.0	56.0	57.1	58.1	59.2	60.2	61.2
42	51.8	52.8	53.8	54.9	55.9	57.0	58.0	59.0	60.1	61.1
43	51.7	52.7	53.7	54.8	55.8	56.9	57.9	58.9	60.0	61.0
44	51.6	52.6	53.6	54.7	55.7	56.7	57.8	58.8	59.8	60.9
45	51.5	52.5	53.5	54.6	55.6	56.6	57.7	58.7	59.7	60.7
46	51.4	52.4	53.4	54.5	55.5	56.5	57.5	58.6	59.6	60.6
47	51.3	52.3	53.3	54.4	55.4	56.4	57.4	58.5	59.5	60.5
48	51.2	52.2	53.2	54.2	55.3	56.3	57.3	58.3	59.4	60.4
49	51.1	52.1	53.1	54.1	55.2	56.2	57.2	58.2	59.3	60.3
50	51.0	52.0	53.0	54.0	55.1	56.1	57.1	58.1	59.1	60.2

125

Table 5

50–59° API API Gravity Reduction to 60° F.

50-100° F.

Observed Temperature °F.	API Gravity at Observed Temperature									
	50	51	52	53	54	55	56	57	58	59
	Corresponding API Gravity at 60° F.									
50	51.0	52.0	53.0	54.0	55.1	56.1	57.1	58.1	59.1	60.2
51	50.9	51.9	52.9	53.9	54.9	56.0	57.0	58.0	59.0	60.0
52	50.8	51.8	52.8	53.8	54.8	55.9	56.9	57.9	58.9	59.9
53	50.7	51.7	52.7	53.7	54.7	55.8	56.8	57.8	58.8	59.8
54	50.6	51.6	52.6	53.6	54.6	55.6	56.7	57.7	58.7	59.7
55	50.5	51.5	52.5	53.5	54.5	55.5	56.5	57.5	58.6	59.6
56	50.4	51.4	52.4	53.4	54.4	55.4	56.4	57.4	58.5	59.5
57	50.3	51.3	52.3	53.3	54.3	55.3	56.3	57.3	58.3	59.3
58	50.2	51.2	52.2	53.2	54.2	55.2	56.2	57.2	58.2	59.2
59	50.1	51.1	52.1	53.1	54.1	55.1	56.1	57.1	58.1	59.1
60	50.0	51.0	52.0	53.0	54.0	55.0	56.0	57.0	58.0	59.0
61	49.9	50.9	51.9	52.9	53.9	54.9	55.9	56.9	57.9	58.9
62	49.8	50.8	51.8	52.8	53.8	54.8	55.8	56.8	57.8	58.8
63	49.7	50.7	51.7	52.7	53.7	54.7	55.7	56.7	57.7	58.7
64	49.6	50.6	51.6	52.6	53.6	54.6	55.6	56.6	57.6	58.5
65	49.5	50.5	51.5	52.5	53.5	54.5	55.5	56.5	57.4	58.4
66	49.4	50.4	51.4	52.4	53.4	54.4	55.4	56.3	57.3	58.3
67	49.3	50.3	51.3	52.3	53.3	54.3	55.3	56.2	57.2	58.2
68	49.2	50.2	51.2	52.2	53.2	54.2	55.1	56.1	57.1	58.1
69	49.1	50.1	51.1	52.1	53.1	54.1	55.0	56.0	57.0	58.0
70	49.1	50.0	51.0	52.0	53.0	54.0	54.9	55.9	56.9	57.9
71	49.0	49.9	50.9	51.9	52.9	53.9	54.8	55.8	56.8	57.8
72	48.9	49.8	50.8	51.8	52.8	53.8	54.7	55.7	56.7	57.6
73	48.8	49.8	50.7	51.7	52.7	53.6	54.6	55.6	56.6	57.5
74	48.7	49.7	50.6	51.6	52.6	53.5	54.5	55.5	56.5	57.4
75	48.6	49.6	50.5	51.5	52.5	53.4	54.4	55.4	56.3	57.3
76	48.5	49.5	50.4	51.4	52.4	53.3	54.3	55.3	56.2	57.2
77	48.4	49.4	50.3	51.3	52.3	53.2	54.2	55.2	56.1	57.1
78	48.3	49.3	50.3	51.2	52.2	53.1	54.1	55.1	56.0	57.0
79	48.2	49.2	50.2	51.1	52.1	53.0	54.0	55.0	55.9	56.9
80	48.1	49.1	50.1	51.0	52.0	52.9	53.9	54.9	55.8	56.8
81	48.0	49.0	50.0	50.9	51.9	52.8	53.8	54.8	55.7	56.7
82	48.0	48.9	49.9	50.8	51.8	52.7	53.7	54.7	55.6	56.6
83	47.9	48.8	49.8	50.7	51.7	52.6	53.6	54.5	55.5	56.4
84	47.8	48.7	49.7	50.6	51.6	52.5	53.5	54.4	55.4	56.3
85	47.7	48.6	49.6	50.5	51.5	52.4	53.4	54.3	55.3	56.2
86	47.6	48.5	49.5	50.5	51.4	52.4	53.3	54.2	55.2	56.1
87	47.5	48.5	49.4	50.4	51.3	52.3	53.2	54.1	55.1	56.0
88	47.4	48.4	49.3	50.3	51.2	52.2	53.1	54.0	55.0	55.9
89	47.3	48.3	49.2	50.2	51.1	52.1	53.0	53.9	54.9	55.8
90	47.2	48.2	49.1	50.1	51.0	52.0	52.9	53.8	54.8	55.7
91	47.2	48.1	49.0	50.0	50.9	51.9	52.8	53.7	54.7	55.6
92	47.1	48.0	48.9	49.9	50.8	51.8	52.7	53.6	54.6	55.5
93	47.0	47.9	48.9	49.8	50.7	51.7	52.6	53.5	54.5	55.4
94	46.9	47.8	48.8	49.7	50.6	51.6	52.5	53.4	54.4	55.3
95	46.8	47.7	48.7	49.6	50.5	51.5	52.4	53.3	54.3	55.2
96	46.7	47.7	48.6	49.5	50.5	51.4	52.3	53.2	54.2	55.1
97	46.6	47.6	48.5	49.4	50.4	51.3	52.2	53.1	54.1	55.0
98	46.5	47.5	48.4	49.3	50.3	51.2	52.1	53.0	54.0	54.9
99	46.5	47.4	48.3	49.2	50.2	51.1	52.0	52.9	53.9	54.8
100	46.4	47.3	48.2	49.2	50.1	51.0	51.9	52.8	53.8	54.7

QMS 300.653 H-1

PETROLEUM
HEALTH & HANDLING
HAZARDS

PROPONENT DEPARTMENT: Petroleum and Field Services

AUGUST 1976

NEW

Introduction

The handling of petroleum products presents many hazards, but both bulk and packaged products can be handled safely if product characteristics are understood and if proper precautionary measures are taken. You must be aquainted with and observe applicable health and handling hazards presented in this class and in other classes presented pertaining to specific operations.

Objective

The student will be able to identify health and handling hazards related to petroleum operations. With knowledge of safety precautions in handling petroleum products and given a specific injury the student will be able to perform necessary first aid of petroleum injuries.

Instruction to Student

Read each page carefully. A question will always follow each statement. Answer the question, then check your answer against the solution at the top of the following page. Answer all questions, when you feel you know everything in the program, notify your instructor.

1. Products such as heavy oils and greases must be heated before they will give off vapor. However, products such as gasoline and jet fuel are volatile (Pass off vapor readily) and give off enough vapor at normal temperature to be ignited by a spark or flame. They are dangerous if not handled properly.

Turn to page 4 and answer question at top of page.

129

Question: Which products give off vapor at normal temperature?

____

Check answer at the top of page 5

2. If petroleum product vapors can be controlled and sources of ignition gotten rid of there will be no danger of fire. However, such a goal cannot be reached. The most that can be done is to understand the problem and to take measures to insure safety.

Turn to page 5 and answer question at top of page.

SOLUTION: Gasolines and Jet Fuels

Question: If petroleum vapors are controlled there is little chance of ____________________.

Turn to top of page 6 for solution.

3. When volatile products are handled, vapors will be produced. If they combine with air in the proper amounts--about one to eight percent by volume for gasoline--they can be ignited. If ignition occurs in a closed space, an explosion results. Because vapor production cannot be avoided, preventive action should be directed towards reducing the chance of ignition.

Turn to page 6 and answer question at top of page.

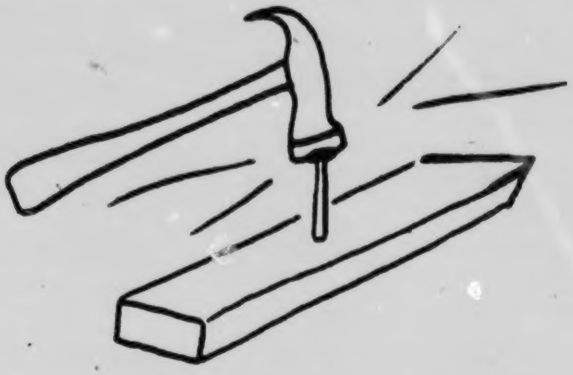
SOLUTION: Fire

4. Sources of ____________________ that cause most fires are strike-anywhere matches and lighted cigarettes, cigars, or pipes. However, there are other common sources.

NOTE: Unless stated otherwise the solution will be on the top of the page following each question.

SOLUTION: ignition

5. Petroleum ___________ can be ignited by sparks caused by striking together metal objects or other hard substances.



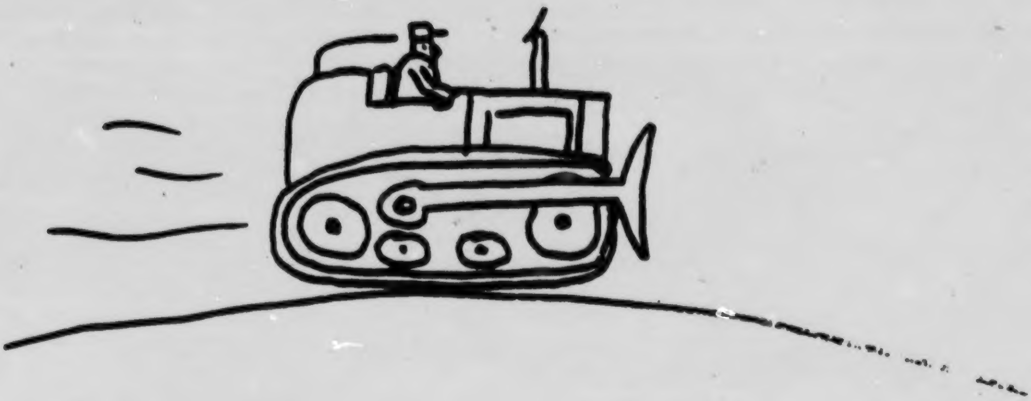
133

SOLUTION: Vapors

6. Petroleum ___________ can also be ignited by arcing or sparking of electrical equipment such as knife switches, circuit breakers, and the turning parts of motors and generators. Therefore, all electrical equipment used where petroleum vapors may collect should meet UL standards. Lights, both portable and fixed, should be explosionproof.

SOLUTION: Vapors

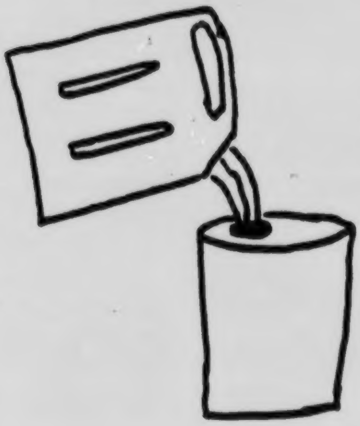
8. Also, static electricity can be produced by ____________________ machines.



135

SOLUTION: Moving

7. Another source of ____________________ is static, or frictional, electricity caused by unlike substances rubbing together. As shown, static electricity is produced by __________________ petroleum liquids from one container into another. It is also produced when petroleum liquids are pumped through pipelines or hoses.



SOLUTION: Ignition, pouring

9. It can be produced by a person's movement or by ________________ vehicles.

SOLUTION: Moving

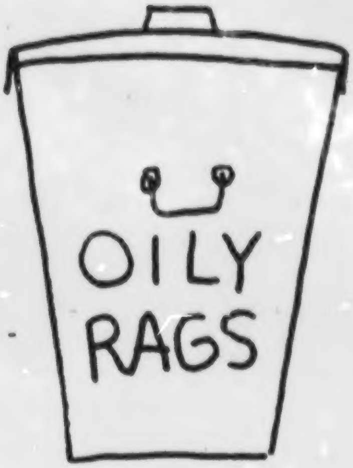
10. As long as this type of electricity stays static, or at rest, it is of no danger. However, when the object or substance in which it has collected nears an object or substance having an opposite charge, a spark may be created. If the spark occurs in a closed area where vapors have collected, an explosion can result. Bonding and grounding are two ways of neutralizing static charges.

11. Another source of ignition is spontaneous heating. This occurs when vapors from materials such as oil- and paint-soaked rags unite with oxygen in poorly ventilated areas. If the heat reaches the ignition temperature of the materials, spontaneous combustion occurs. Although complete lack of air will usually prevent spontaneous ________________, ignition can take place if a chemical source of oxygen is present in the materials.

139

SOLUTION: Combustion

12. Because oil-soaked rags are common in petroleum handling areas and because they can be the source of spontaneous combustion, they should be disposed of as soon as possible. Until this can be done, the best fire prevention measure is to store them in airtight metal containters.



13. Besides being sources of fires, petroleum products can be health hazards. Petroleum gases and vapors are dangerous if inhaled, and petroleum liquids can be fatal if swallowed. Also, petroleum liquids can be harmful if they get on the skin and are allowed to stay for long periods.

141

14. Petroleum-related substances which may be ________________ into the lungs or swallowed or which may contaminate the skin are in several form, such as dusts, gases and vapors, and liquids.

SOLUTION: Breathed (inhaled)

15. Dusts range from very toxic, or poisonous, to mildly irritating. Those which are toxic injure organs and tissues when they are _______________ into the lungs or swallowed.

One of the most toxic dusts is that caused during cleaning and repairing tanks that have held leaded gasoline.

143

SOLUTION: breathed (inhaled)

16. Some dusts, when ________________, injure the lungs by destroying normal tissue by abrasion. This produces scar tissue. Such dusts can result from grinding, polishing, sanding, and sandblasting.

SOLUTION: Breathed (inhaled)

17. Other dusts are only irritating and do not damage the lungs or the digestive system. However, they can bring on or worsen a respiratory disease. If these irritating, or nuisance, dusts are flammable, they can be more of a ____________ hazard than a ________________ hazard.

145

SOLUTION: Fire, health

18. The next form of health hazard is gases and ____________________. Like dusts, these range from poisonous to only irritating. Some cause choking, and some cause a numbing of the senses.

> NOTE: A gas is often thought to be the same as a vapor, but there is a difference. A gas is a substance that exists as a gas at ordinary temperature and pressure; a vapor is a gaslike form of a substance that ordinarily exists as a solid or as a liquid.

SOLUTION: Vapors

19. Poisonous gases and vapors have various effects on the body, such as injuring or destroying interior organs, tissues, and bones. Breathing poisonous gases and vapors have much the same effect as breathing ________________ __________________.

SOLUTION: poisonous dusts

20. One of the most dangerous gases that a person handling crude oil of a high sulfur content can come in contact with is hydrogen sulfide. One of the most dangerous vapors that a person handling leaded gasoline can come in contact with is TEL (tetraethyllead) vapor. Both of these can be fatal.

21. Some of the less toxic gases and vapors keep the lungs from absorbing oxygen by replacing oxygen in the air breathed, and others prevent the red blood cells from carrying enough oxygen to the brain and other vital organs. Still others have a narcotic, or numbing, effect on the central nervous system and can cause breathing to stop. Gasoline and jet fuel are in the last group.

22. Just as nuisance dusts can cause irritation in the ____________, or can make a respiratory ailment worse, so can irritant ____________ and ____________.

SOLUTION: Lungs, gases, and vapors

23. The last health hazard to be mentioned is flammable liquid petroleum products. These are very dangerous if swallowed and may be fatal. But they are also dangerous if allowed to come in contact with the skin for any length of time. Fuels and solvents remove the natural oils from the skin and cause it to become dry and cracked. Broken skin invites infection.

24. Two basic methods of preventing petroleum product fires are controlling vapors and getting rid of sources of ignition.

__________ TRUE

__________ FALSE

152

SOLUTION: True

25. Pouring petroleum liquids from one container into another can create what kind of electricity? ____________

153

SOLUTION: Static (or frictional)

26. Heat caused when vapors in piles of oil-soaked rags unite with oxygen is called ____________________heating.

SOLUTION: Spontaneous

27. Three ways petroleum products are hazardous to health are breathing dusts, gases, and vapors; swallowing liquids; and letting liquids stay on the skin too long.

_______ TRUE

_______ FALSE

155

SOLUTION: TRUE

28. One of the most toxic dusts is that created when tanks that have held leaded gasoline are cleaned.

________ TRUE

________ FALSE

SOLUTION: True

29. Circle the letters in front of the two most toxic gases or vapors.

    a. Hydrogen sulfide.

    b. TEL vapor.

    c. Carbon dioxide.

    d. Nitrogen.

SOLUTION: a & b

30. Fuels and solvents remove the natural oils from the skin and can cause it to become chapped. This can lead to infection.

_________ TRUE

_________ FALSE

SOLUTION: True

FIRST AID

Petroleum products are a health hazard and can enter the body through breathing and skin contact. Health hazards are the concern of both the handlers and users of petroleum products. Since they cannot be eliminated, personnel must be aware of them and use approved safeguards and precautions as a matter of habit. The effects of a petroleum injury can be classified as to whether it is produced by inhalation into the lungs, by injestion into the digestive system (stomach) or by mere skin contact. Each method by which petroleum products can enter the body is discussed in this section along with the procedure for you to follow should any portion of your body come in contact with them.

1. Inhalation: (Breathing) - Inhalation of petroleum products can cause dizziness, nausea and headaches; large amounts may cause unconscious. When working around petroleum products, should a person get dizzy, nauseous or have a headache, remove him/her from the area immediately. For the unconscious injury remove from the danger area and give artificial respiration, call a physician.

TURN TO NEXT PAGE AND FILL IN THE BLANK

31. You are top loading a 5,000 gallon tanker and you experience dizziness. What action should you take? ______________________________

____

TURN TO NEXT PAGE FOR SOLUTION

SOLUTION: Remove yourself from the immediate area

32. Should petroleum products be swallowed do not induce vomiting but send for medical personnel immediately.

33. If a petroleum product is swallowed is vomiting induced? Yes/No

TURN TO NEXT PAGE FOR SOLUTION

SOLUTION: No

34. Skin contact: The seriousness of skin contamination ranges widely, depending upon the petroleum product. The effects produced by these products must not be taken lightly. Fuels and solvents effects the skin by removing the natural fate and oils. This results in harsh dry chapped skin surfaces. The general condition is known as dermatitis. Infection can result in cuts and scratches. Gasoline will cause serious burns if allowed to remain in contact with the skin, particularly where the contact is maintained under soaked clothing. Clothing or shoes soaked in gasoline should be removed at once in a well ventilated area free from ignition sources. As soon as possible wash thoroughly with soap and water. If gasoline comes in contact with the eyes, flush thoroughly with water and seek medical attention. Proper handling precaution should be used and the wearing of rubber gloves should prevent any skin contact from occurring.

TURN TO NEXT PAGE AND ANSWER QUESTIONS.

35. A. Your clothing is soaked with gasoline, what procedure will you use? ______________________________

____

B. You have gasoline in your eye. How will you remove the substance?

____

____

TURN TO NEXT PAGE FOR SOLUTION

SOLUTION: A. Undress, wash and wash clothing

B. Flush thoroughly with water and seek medical attention.

Review this entire booklet until you feel that you can answer all the questions it contains without help! When you think you can, tell your instructor.

165

Here is a list of the basic health and handling equipment and precautions you should keep in mind when working with petroleum.

If you see something in this list that you don't understand - ask your instructor to explain it to you.

A. IMPORTANCE OF SAFETY

NOTE: Instructor, this is covered in programmed text.

166

(1) Safe working area only authorized personnel.

  (a) Control traffic flows.
  (b) Standard operations procedure inforced.
  (c) Fire plan tested.
  (d) Safety signs posted and color coded.
  (e) Fire extinguishers promently located and operational.
  (f) Equipment serviceable.
  (g) Stability of storage containers or stacks.

(2) Availability of safety clothing and equipment.

  (a) Eye protection goggles.
  (b) Gloves to fit the task - leather/rubber.
  (c) Helmets (hard hats).
  (d) Ear plugs or muffs.
  (e) Rubber boots.
  (f) Protective mask (gas).
  (g) Spill clean up equipment.
  (h) Explosimeter.
  (i) Hydrogen sulfide detector.

(3) Safety tools.

  (a) Explosion proof light or fixtures.
  (b) Safety harness.
  (c) Safety equipment set.
  (d) Containers for combustibles (properly marked).
  (e) Multimeter (to check bonding and grounding).
  (f) Explosion proof power tools.

B. HAZARDS AND PREVENTIONS.

(1) Control vapor formation.

  (a) Leaking container (replaced).
  (b) Empty containers (closed).
  (c) Spills (clean up and disposal).
  (d) Unventilated or confined areas (check with explosimeter).

(2) Control ignition sources.

  (a) Electric motors or generators (insulated IAW ULS).
  (b) Power units for pumps (spark or flame arrester).
  (c) Mechanical or friction (frequent inspection).
  (d) Static electricity (Proper bonding and grounding).
  (e) Spontaneous combustion (closed container or ventilation).
  (f) Welding and cutting (only authorized).
  (g) Electrical storms (act of God, not controlable.)

(3) Housekeeping procedures.

- (a) Area clean of rubbish (placed in containers).
- (b) Loose tools (controlled).
- (c) Cleaning agents (only authorized solvent).
- (d) Ladders, stairways, handrails and scaffolds (inspected daily).
- (e) Ice, snow, oil spillage and wet area (cautions observed).
- (f) Machinery (MHE) (authorized or licensed personnel only).

(4) Hygienie health aspects.

- (a) Facilities for washing hands, etc.
- (b) Facilities for showering.
- (c) Avoid skin contact.
- (d) Avoid breathing in (inhalnation of vapors, gases or dust).

A-5

FIRE FIGHTING EQUIPMENT AND PROCEDURES

Introduction: Sometimes fires start despite what we think are the very best precautions taken. When you are finished with this text, should a fire start, you will be able to identify the type of fire and select and use the appropriate equipment to extinguish a fire. Besides fire fighting, this text will teach you how to inspect extinguishers and fill out DA Form 253 (Fire Extinguisher Tag) to insure that the equipment is operational.

Objective: The student will be able to:

1. Identify classes of fires and select the proper fire fighting extinguishers.
2. Name the three elements that make up fire.
3. Inspect fire extinguishers common to petroleum units.
4. Use the proper procedures in reporting a fire.
5. Complete DA Form 253 (Fire Extinguisher Tag).

Instruction: Before starting the text beginning on the next page, see the three (3) TV films on Fire Fighting at fire fighting station in building 11400.

PROPONENT DEPARTMENT: Petroleum and Field Services

November 1976

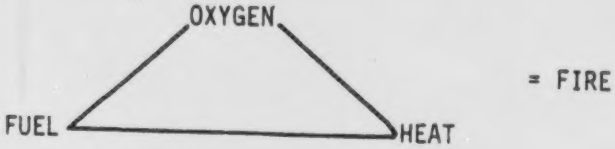
Lesson I: Elements of Fires.

1. There are three elements needed to start a fire. Fires in some ways are like human beings. Where humans need food, shelter, and air; fires need fuel, heat, and oxygen. Let's take a look at each element by itself.

a. Fuel - any kind of combustible material.

b. Heat - ignition caused by another flame, spark, or by physical heat alone.

c. Oxygen - there must be a proper amount of air or oxygen for fire to feed on.



d. Remove any one of these elements and it is not possible to start a fire, but put them all together in proper amounts, and you will instantly cause combustion.

Lesson I

Directions: Fill in the blank spaces for items 1 and 2.

1. Name the three elements of fire. ______________________________,
______________________________ and ______________________________.

2. If any one of these elements is removed the fire ________________
____.

TURN THE PAGE

Lesson I Solution

1. Fuel, heat, oxygen

2. Would not start

Instructions to Student: If your answers agree start Lesson II. If your answers do not agree, read Lesson I again, correct your answers then go to Lesson II.

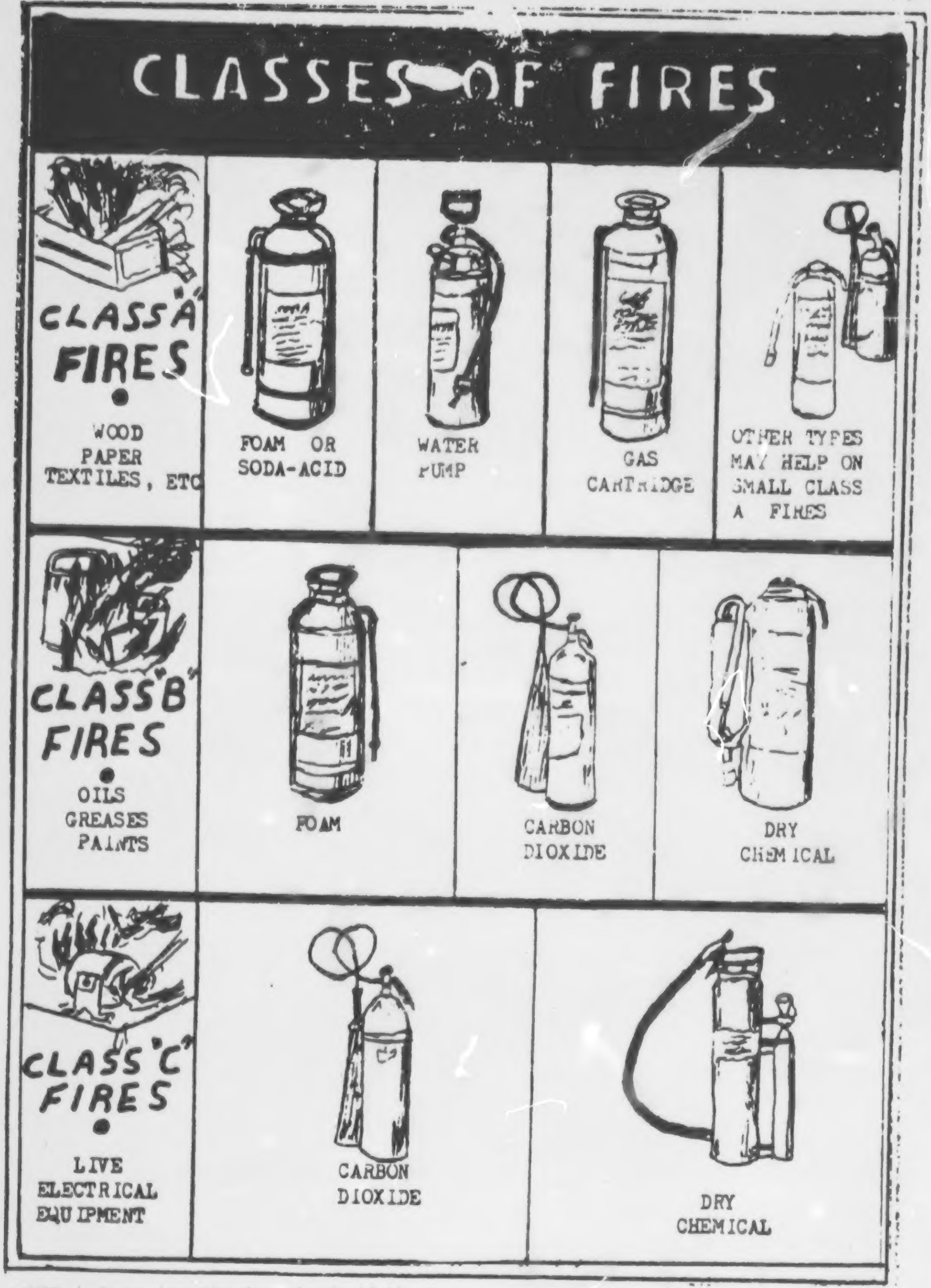
Lesson II: Classes of Fires

1. Fires are most commonly caused by rags left in closed areas, petroleum products, and electrical equipment. The classification of fire permits the most effective use of different kinds of fire extinguishing agents and methods. Some extinguishing agents that are suitable for one class of fire may not be suitable for others. The Underwriter's Laboratories Incorporated has grouped fires into three classes: A, B and C.

a. Class A Fires - ordinary combustibles such as wood, brush, grass and rubbish. Water, foam, soda water and vaporizing liquid extinguishers are the most effective agents. The most common extinguisher is water for Class A fires.

b. Class B Fires - Flammable liquids such as gasoline and other fuels, solvents, lubricants, paints, and similar substances. A smothering agent is needed such as foam, carbon dioxide, or dry chemical. Foam is the most effective means of extinguishing this type of fire. The most common extinguisher found in petroleum units is carbon dioxide.

c. Class C Fires - involve electrical equipment, such as electrical wiring, motors, switches, and transformers. A smothering agent is preferred for extinguishing, but of equal importance, DO NOT USE WATER AGENTS since water is an electrical conductor. Carbon dioxide and dry chemicals are the best agents. NOTE See figure on page 5.


CLASSES OF FIRES
CLASS "A" FIRES
WOOD
PAPER
TEXTILES, ETC
FOAM OR
SODA-ACID
WATER
PUMP
GAS
CARTRIDGE
OTHER TYPES
MAY HELP ON
SMALL CLASS
A FIRES
CLASS "B" FIRES
OILS
GREASES
PAINTS
FOAM
CARBON
DIOXIDE
DRY
CHEMICAL
CLASS "C" FIRES
LIVE
ELECTRICAL
EQUIPMENT
CARBON
DIOXIDE
DRY
CHEMICAL

NOTE: See the display in building 11400 for types of extinguishers not shown above.

Lesson II

Directions: Fill in the blank spaces for items 1 - 4.

1. A forest fire is a Class _________ fire.

2. Burning paint thinner would be a Class _______ fire.

3. A burning electrical drill would be a Class ________ fire.

4. What type of fire extinguisher would be used on wood fires?

____.

Lesson II Solution.

1. A

2. B

3. C

4. Water pump

Instructions to student: If your answers agree start Lesson III. If your answers do not agree, read Lesson II again, correct your answers, then go to Lesson III.

Lesson III: Principles of Extinguishing Fires.

We have discussed the three elements that make up fire. Let's now discuss methods of extinguishing fires. We know fire = heat + oxygen + fuel. All three have to be present to make fire burn. We remove one of the three sources by the following methods.

1. Remove heat by cooling.

2. Remove oxygen by smothering.

3. Remove fuel by starving.

NOTE: Each type of fire extinguisher performs one of the first two methods (cooling or smothering).

Lesson III

Directions: Fill in blank spaces for items 1-3.

1. If heat is removed from a fire, it is called ______________________.

2. If oxygen is removed from a fire, it is called ____________________.

3. If fuel is removed from a fire, it is called ______________________.

175

Lesson III Solution

1. Cooling

2. Smothering

3. Starving

Instructions to student: If your answers agree start Lesson IV. If your answers do not agree, read Lesson III again, correct your answers, then go to Lesson IV.

Lesson IV: Types of Fire Fighting Equipment.

The Army uses both portable hand extinguishers and wheeled units. Portable hand extinguishers are available in various sizes and types. Portable extinguishers are most effective in the earliest stages of fire, because of this, they are called the first aid appliances. Wheeled types of units are available in all types and have a greater capacity then the portable. There are six types of fire extinguishers common to petroleum units. (See the different types on page 5 and also in the display).

Lesson IV

Directions: Fill in the blank spaces beside the letters below.

1. Name the six types of fire extinguishers.

   a.

   b.

   c.

   d.

   e.

   f.

Lesson IV Solution

a. Soda and acid

b. Water

c. Foam

d. Vaproizing liquid

e. Carbon dioxide

f. Dry chemical

Instructions to student: If your answers agree go on to Lesson V. If your answers do mot agree, read Lesson IV, correct your answers, then go on to Lesson V.

Lesson V: Inspection of Fire Fighting Equipment.

When making an inspection of any type of fire extinguisher, take the following action:

1. Examine the surrounding area to make sure the extinguisher is accessible under actual fire conditions and that there are no mechanical damages.

2. Have all obstructions removed which may hide extinguisher from view or prevent you from getting to it quickly.

3. If necessary, change the type of extinguisher or add new units.

4. See that extinguisher is located in the right place to meet existing fire regulation.

5. Check hanging brackets or support for security of extinguisher and see that extinguisher is easily removeable.

5. Check fire extinguisher to see if seal is broken, if broken, turn in to the fire department for check and refill if necessary.

7. DA Form 253 (Fire Extinguisher Record Tag). This log is attached to each extinguisher, each month extinguishers must be inspected by unit personnel and data recorded on this tag. (See Page 16). The following information must be filled out on DA Form 253.

a. Extinguisher type - water, foam, etc.

b. Number - number of fire extinguisher.

c. Building number - use when applicable.

d. Extinguisher location - fire point.

e. Weight empty - check data plate.

f. Rated capacity - amount of agent contained in the fire extinguisher.

g. Weight charge - amount of agent and extinguisher.

h. Date - use actual inspection date.

i. Inspection/Recharge - check either block that applies.

j. Remarks - fill in OK if operational or note any shortcomings.

k. Name - sign your name.

Lesson V

Directions: Fill in blank for item 1, do situation 2 using blank tag on page 16, last page.

1. Fire extinguishers are inspected how often by unit personnel?

____

2. Situation: You are at building number 11400, it is time for inspection of fire extinguishers. The old tag is completely filled in. With the following information, fill out a new card using pages 16. Type of extinguishers is water, number of extinguishers is number 1, located at fire point 2, weight empty is 2 pounds, charged, 10 pounds.

3. What is the rated capacity? __________________________

Lesson V Solution

1. Monthly
2. See figure on page 15.
3. 8 pounds

Instructions to student: If your answers agree go on to Lesson VI. If your answers do not agree, read Lesson V, correct your answers, then go on to Lesson VI.

Lesson VI: Responsibilities of Fire Department and Unit Personnel.

The responsibility for taking care of fire fighting equipment falls into two groups, fire department and unit personnel.

1. Damaged extinguisher - fire department.
2. Replacing seals - fire department.
3. Malfunctions - fire department.
4. Change of charge - fire department.
5. Winterization - fire department.
6. Replacing DA Form 253 - unit personnel.

Lesson VI

Directions: Fill in blank spaces for items 1 - 3.

1. Who is responsible for replacing DA Form 253? ______________________

2. A fire extinguisher is damaged; who is responsible for replacement?

____

3. A fire extinguisher needs recharging; who is responsible?

____

Lesson VI Solution

1. Unit personnel

2. Fire department

3. Fire department

Instruction to student: If your answers agree go on to Lesson VII. If your answers do not agree, read Lesson VI, correct your answers, then go to Lesson VII.

Lesson VII: How to Report a Fire.

In order to save time when a fire starts, follow the instructions on how to report a fire. Depending on the post or installation, the number for the fire department will vary, but will always end with the number 17. Emergency numbers are always placed in a conspicuous place.

Actions taken by individuals upon discovering a fire:

1. Warn all occupants in the building. If in the PTF, shout "FIRE" repeatedly. When you hear the shout repeat and relay the shout to the operations office.

2. If you have a dial phone, DIAL 817. You will be connected directly with the main fire station at Fort Lee.

3. If near a fire reporting telephone (red boxes outside, identified by red and white bands and red bulb at night), lift receiver and you will be connected directly with the main fire station.

4. When the fire station operator answers the call, give the building number and/or the type of fire, and where the fire is located. If a fire occurs in the PTF, report location as follows: Petroleum Training Facility, Training Area 20 at 40th Street and G Avenue. Let the fire station operator repeat this back to you.

5. The individual reporting a fire should ensure that the fire truck and other emergency vehicles are directed to the scene of the fire.

6. All personnel of this installation should acquaint themselves with the location of the nearest fire alarm box, telephone, and/or fire reporting telephone, and the way to describe the location of buildings in their particular area.

7. All fires which occur at this installation, no matter how minor the nature, will be promptly reported to the Post Fire Department.

8. Extinguish the fire if possible by means of available fire appliances (fire extinguishers, sand, etc.).

9. STAY CALM - DON'T PANIC!

NOTE: Remember that no matter where you are you should follow these procedures; notify occupants of the building or area if you detect fire, contact post fire station, remain in vicinity of fire to assist in fighting/emergency operations.

Lesson VII

Directions: Fill in blank space.

What is phone number for the main fire station at Fort Lee? ____________

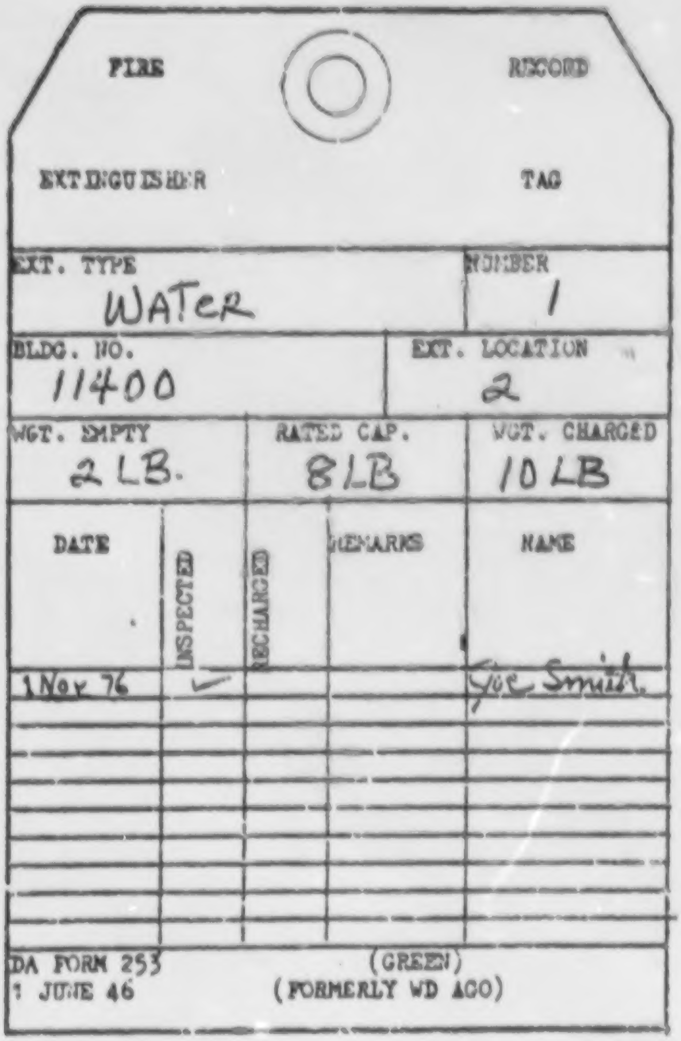
181

Lesson VII Solution

617

Instruction to student: If your answers agree, you have completed this text. You may start another text. If your answers do not agree, read and correct.

Discussion: What you have taught yourself is one step toward becoming a Petroleum Supply Specialist. Good Luck!

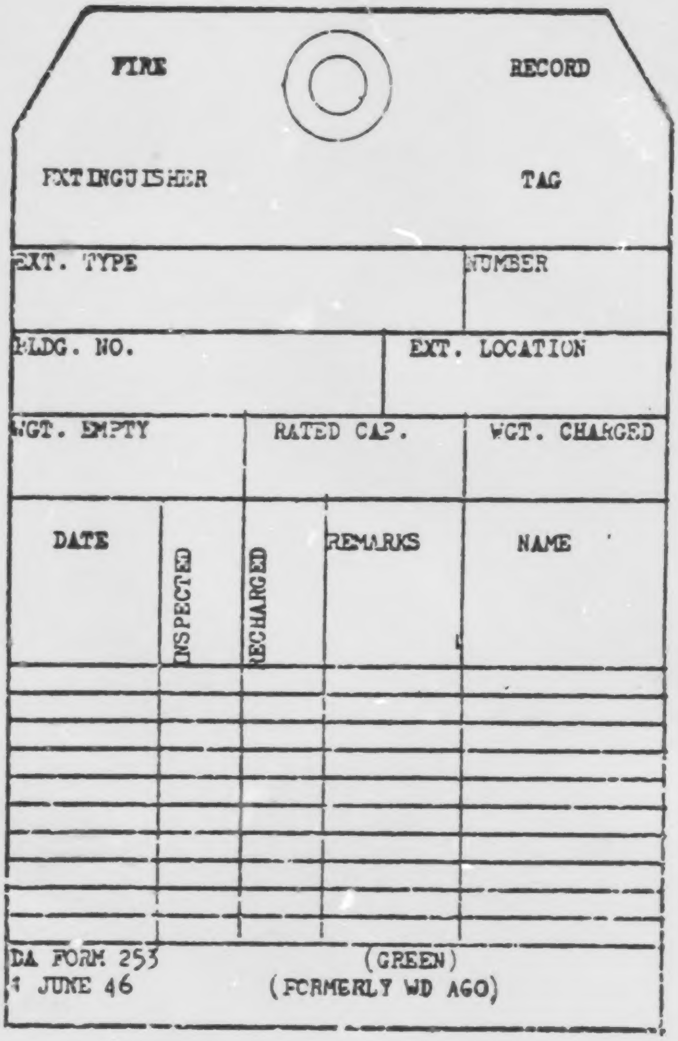


FIRE RECORD
EXTINGUISHER TAG

EXT. TYPE WATER		NUMBER 1
BLDG. NO. 11400		EXT. LOCATION 2
WGT. EMPTY 2 LB.	RATED CAP. 8 LB	WGT. CHARGED 10 LB

DATE	INSPECTED	RECHARGED	REMARKS	NAME
1 Nov 76	✓			Joe Smith

DA FORM 253 (GREEN)
1 JUNE 46 (FORMERLY WD AGO)



FIRE RECORD

EXTINGUISHER TAG

EXT. TYPE

NUMBER

BLDG. NO.

EXT. LOCATION

WGT. EMPTY

RATED CAP.

WGT. CHARGED

DATE	INSPECTED	RECHARGED	REMARKS	NAME

DA FORM 253
4 JUNE 46

(GREEN)
(FORMERLY WD AGO)

THE ARMY MAINTENANCE MANAGEMENT SYSTEM

TAMMS

Every soldier who operates or maintains equipment is involved in the Army Maintenance Management System. TAMMS is a system used to record information and keep a record of Army equipment. All events during the life cycle of equipment are recorded. TAMMS works much like the medical record kept for each soldier throughtout his life in the military.

OBJECTIVE

Given TM 38-750, maintenance records (DA Form's 2400, 2404, 2406-1, 2408-14) and problem situations, prepare equipment maintenance records with not more than one incorrect entry.

TURN THE PAGE

MAY 1977

THIS SUPERSEDES QMS 222.3-11H1 DATED
AUGUST 1976

185

This program teaches you the basic information you need to prepare TAMMS forms. The program contains directions to guide you through the material. Read each page and perform whatever actions you are told to do. You can go back over any material at any time - no matter where you are in the book.

If you have any questions, ask an instructor for help. If you get stuck, remember that you can go back over any material at any time.

Work at your own pace and read each page and directions carefully.

Ready? If so - flip the page and get started. Good luck!

TURN THE PAGE

INTRODUCTION

EACH BOX HAS A STATEMENT AND A QUESTION BASED ON THE STATEMENT. READ EACH STATEMENT CAREFULLY - THEN FILL IN THE ANSWER TO THE QUESTION. YOU CAN CHECK YOUR ANSWERS BY READING THE DISCUSSION ON PAGE 5.

1a. As a 76W10 Petroleum Supply Specialist you will be required to inspect equipment or operate equipment.

FILL IN THE ANSWER BASED ON THE STATEMENT YOU JUST READ -

1b. What are two jobs you will perform in your MOS? ____________________
____________________.

GO ON TO NEXT FRAME
CHECK YOUR ANSWER ON PAGE 4

2a. Any time you inspect or operate equipment you will be required to prepare TAMMS forms.

2b. At what times must equipment operators prepare TAMMS forms?
____.

GO ON TO NEXT FRAME
CHECK YOUR ANSWER ON PAGE 4

3a. 76W10 Petroleum Supply Specialists must know the entries required to prepare: DA Form 2400, DA Form 2404, DA Form 2408-1.

3b. What TAMMS forms do equipment operators prepare? ________________,
______________________ and ___________________.

GO ON TO NEXT FRAME
CHECK YOUR ANSWER ON PAGE 4

4a. Petroleum Supply Specialists must know how to use DA Form 2408-14, but they do not prepare DA Form 2408-14.

4b. What is one TAMMS form a 76W20 will use but will not write on?
________________________.

TURN PAGE TO CHECK YOUR ANSWERS

DISCUSSION

Answer to 1b: Inspect equipment and operate equipment

Answer to 2b: When they inspect or operate equipment

Answer to 3b: Equipment operators prepare DA Form 2400, 2404 and 2408-1

Answer to 4b: Equipment operators use DA 2408-14, BUT DO NOT prepare this form.

HOW DID YOU DO?

IF YOU HAVE ANY QUESTIONS - CALL AN INSTRUCTOR

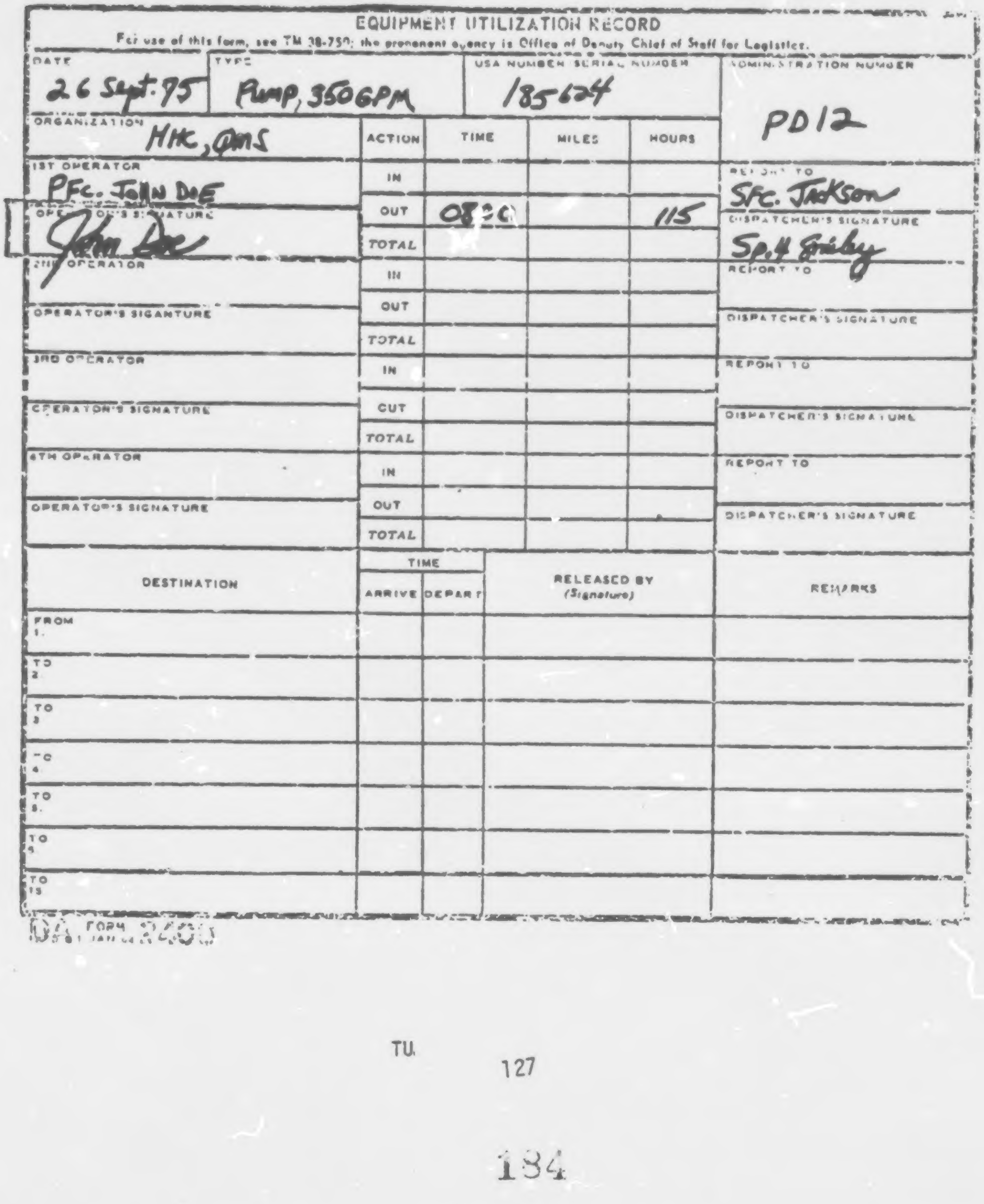
IF YOU FEEL READY - TURN THE PAGE AND CONTINUE THE PROGRAM

DA FORM 2400 (EQUIPMENT UTILIZATION RECORD)

EXAMPLE:

On 26 Sep 75 PFC John Doe reported for work at 0800. The dispatcher prepared a DA Form 2400 (also called a TRIP TICKET) for PFC Doe so he could operate a pump. All Doe had to do was sign his name and go to work.

HERE'S HOW DOE'S DA FORM 2400 LOOKED. STUDY THE FORM, THEN TURN THE PAGE.



EQUIPMENT UTILIZATION RECORD

For use of this form, see TM 38-750; the proponent agency is Office of Deputy Chief of Staff for Logistics.

DATE: 26 Sept. 75
TYPE: Pump, 350GPM
USA NUMBER SERIAL NUMBER: 185624
ADMINISTRATION NUMBER: PD12
ORGANIZATION: HHC, QMS

	ACTION	TIME	MILES	HOURS	
1ST OPERATOR: PFC. JOHN DOE	IN				REPORT TO: SFC. Jackson
OPERATOR'S SIGNATURE: John Doe	OUT	0800		115	DISPATCHER'S SIGNATURE: Sp.4 Grisby
	TOTAL				
2ND OPERATOR	IN				REPORT TO
OPERATOR'S SIGANTURE	OUT				DISPATCHER'S SIGNATURE
	TOTAL				
3RD OPERATOR	IN				REPORT TO
OPERATOR'S SIGNATURE	OUT				DISPATCHER'S SIGNATURE
	TOTAL				
4TH OPERATOR	IN				REPORT TO
OPERATOR'S SIGNATURE	OUT				DISPATCHER'S SIGNATURE
	TOTAL				

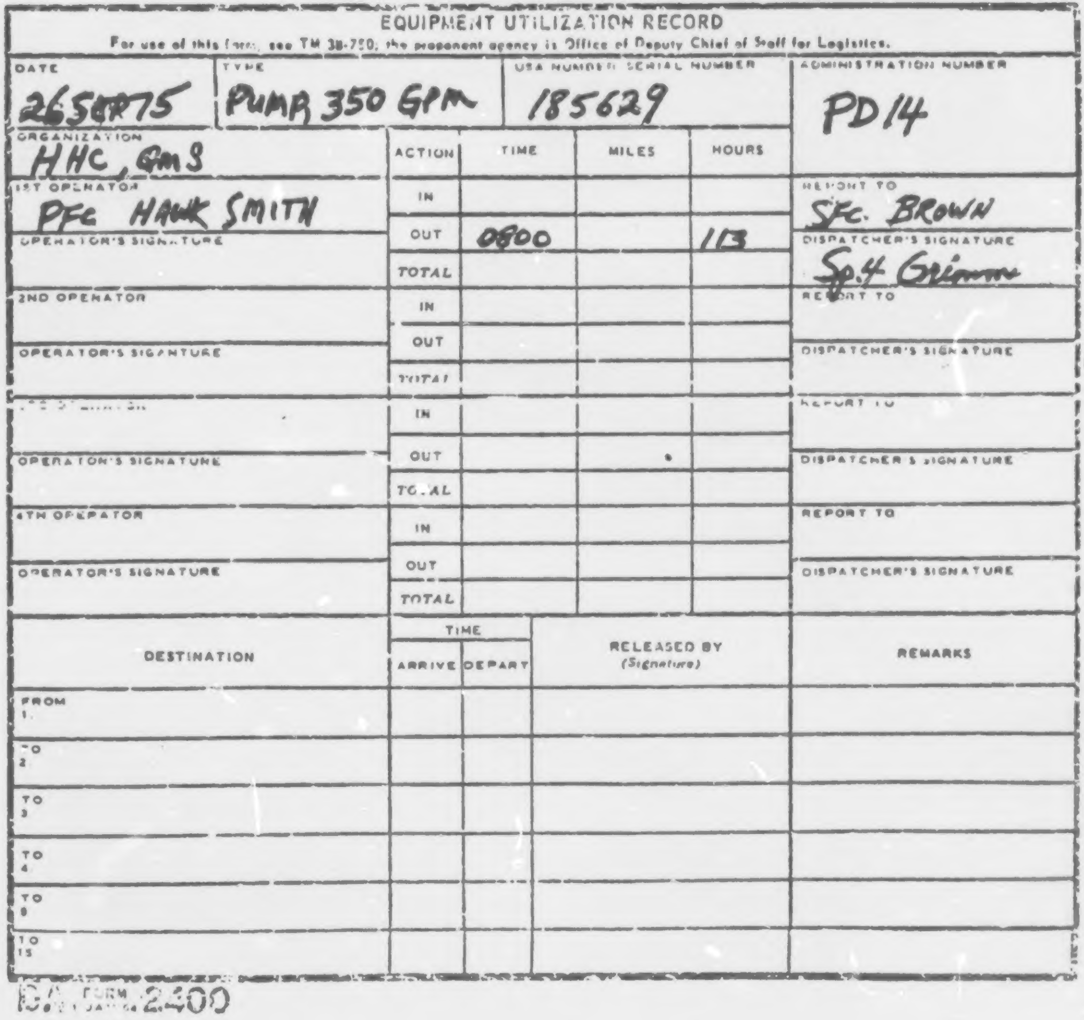
DESTINATION	TIME		RELEASED BY (Signature)	REMARKS
	ARRIVE	DEPART		
FROM 1.				
TO 2				
TO 3				
TO 4				
TO 5.				
TO 6				
TO 7				

DA FORM 2400

FILL IN THE ANSWERS BELOW

SITUATION:
At 0800 on 26 Oct 75, PFC Hank Smith reported for work. The dispatcher gave Smith a trip ticket to operate a pump. Then Smith signed his name as the operator and went to work.

HOW DO YOU THINK SMITH'S DA FORM 2400 LOOKED?
YOU FILL IN THE ENTRY PFC SMITH MADE ON THE FORM BELOW. CHECK YOUR ANSWER ON NEXT PAGE.



EQUIPMENT UTILIZATION RECORD

For use of this form, see TM 38-750; the proponent agency is Office of Deputy Chief of Staff for Logistics.

DATE 26SEP75	TYPE PUMP 350 GPM	USA NUMBER/SERIAL NUMBER 185629	ADMINISTRATION NUMBER PD14

	ACTION	TIME	MILES	HOURS	
ORGANIZATION HHC, GMS					
1ST OPERATOR PFC HANK SMITH	IN				REPORT TO SFC. BROWN
OPERATOR'S SIGNATURE	OUT	0800		113	DISPATCHER'S SIGNATURE Sp.4 Grimm
	TOTAL				
2ND OPERATOR	IN				REPORT TO
OPERATOR'S SIGNATURE	OUT				DISPATCHER'S SIGNATURE
	TOTAL				
3RD OPERATOR	IN				REPORT TO
OPERATOR'S SIGNATURE	OUT				DISPATCHER'S SIGNATURE
	TOTAL				
4TH OPERATOR	IN				REPORT TO
OPERATOR'S SIGNATURE	OUT				DISPATCHER'S SIGNATURE
	TOTAL				

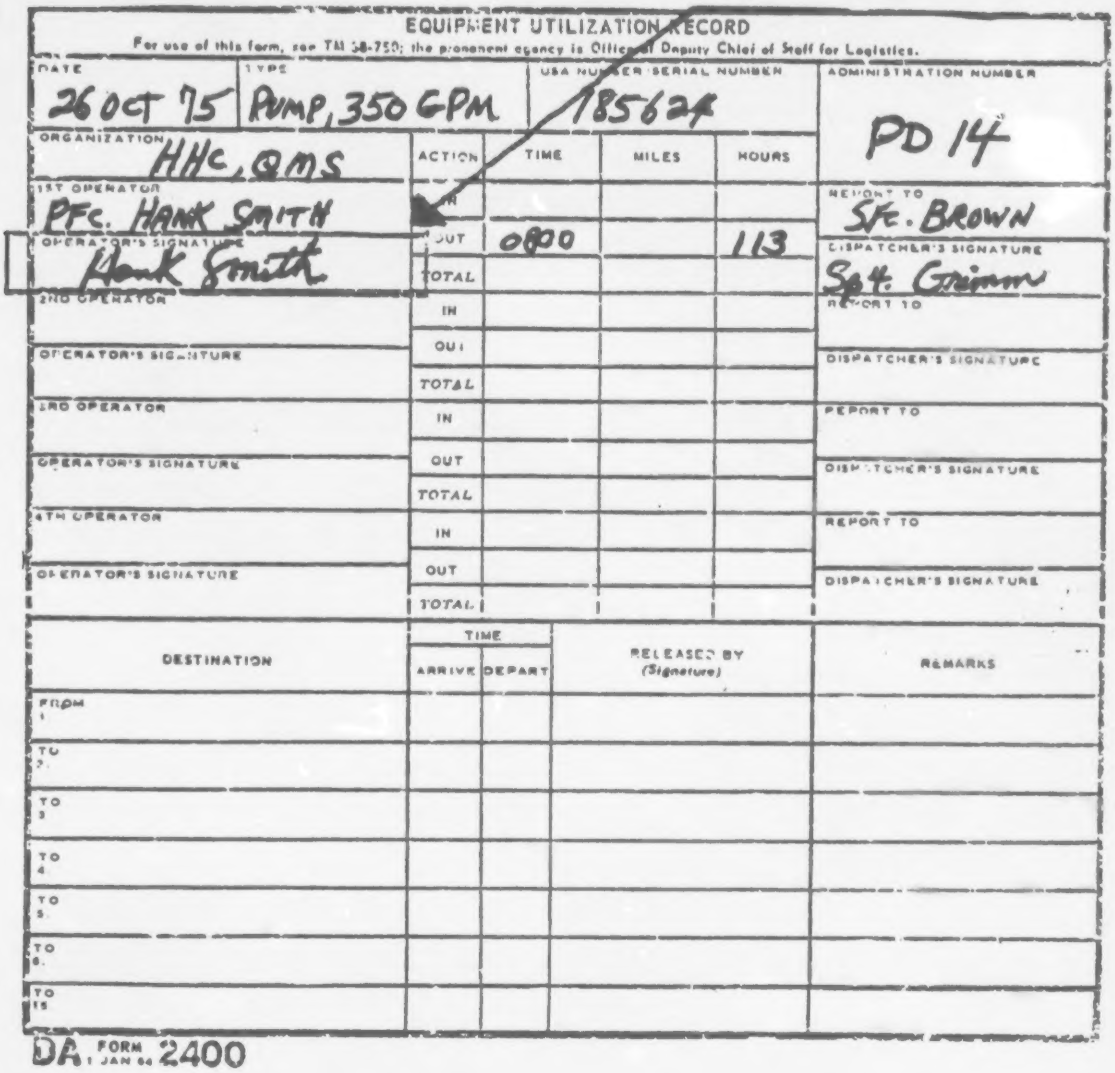
DESTINATION	TIME ARRIVE	TIME DEPART	RELEASED BY (Signature)	REMARKS
FROM 1.				
TO 2				
TO 3				
TO 4				
TO 5				
TO 15				

DA FORM 2400

TURN PAGE FOR DISCUSSION

DISCUSSION

You should have written "PFC Hank Smith" in the Operator's Signature block.



EQUIPMENT UTILIZATION RECORD

For use of this form, see TM 38-750; the proponent agency is Office of Deputy Chief of Staff for Logistics.

DATE 26 OCT 75	TYPE PUMP, 350 GPM	USA NUMBER SERIAL NUMBER 185624	ADMINISTRATION NUMBER PD 14

ORGANIZATION HHC, QMS	ACTION	TIME	MILES	HOURS	
1ST OPERATOR PFC. HANK SMITH	IN				REPORT TO SFC. BROWN
OPERATOR'S SIGNATURE Hank Smith	OUT	0800		113	DISPATCHER'S SIGNATURE Sp4. Grimm
	TOTAL				
2ND OPERATOR	IN				REPORT TO
OPERATOR'S SIGNATURE	OUT				DISPATCHER'S SIGNATURE
	TOTAL				
3RD OPERATOR	IN				REPORT TO
OPERATOR'S SIGNATURE	OUT				DISPATCHER'S SIGNATURE
	TOTAL				
4TH OPERATOR	IN				REPORT TO
OPERATOR'S SIGNATURE	OUT				DISPATCHER'S SIGNATURE
	TOTAL				

DESTINATION	TIME		RELEASED BY (Signature)	REMARKS
	ARRIVE	DEPART		
FROM 1				
TO 2				
TO 3				
TO 4				
TO 5				
TO 6				
TO 7				

DA FORM 1 JAN 64 2400

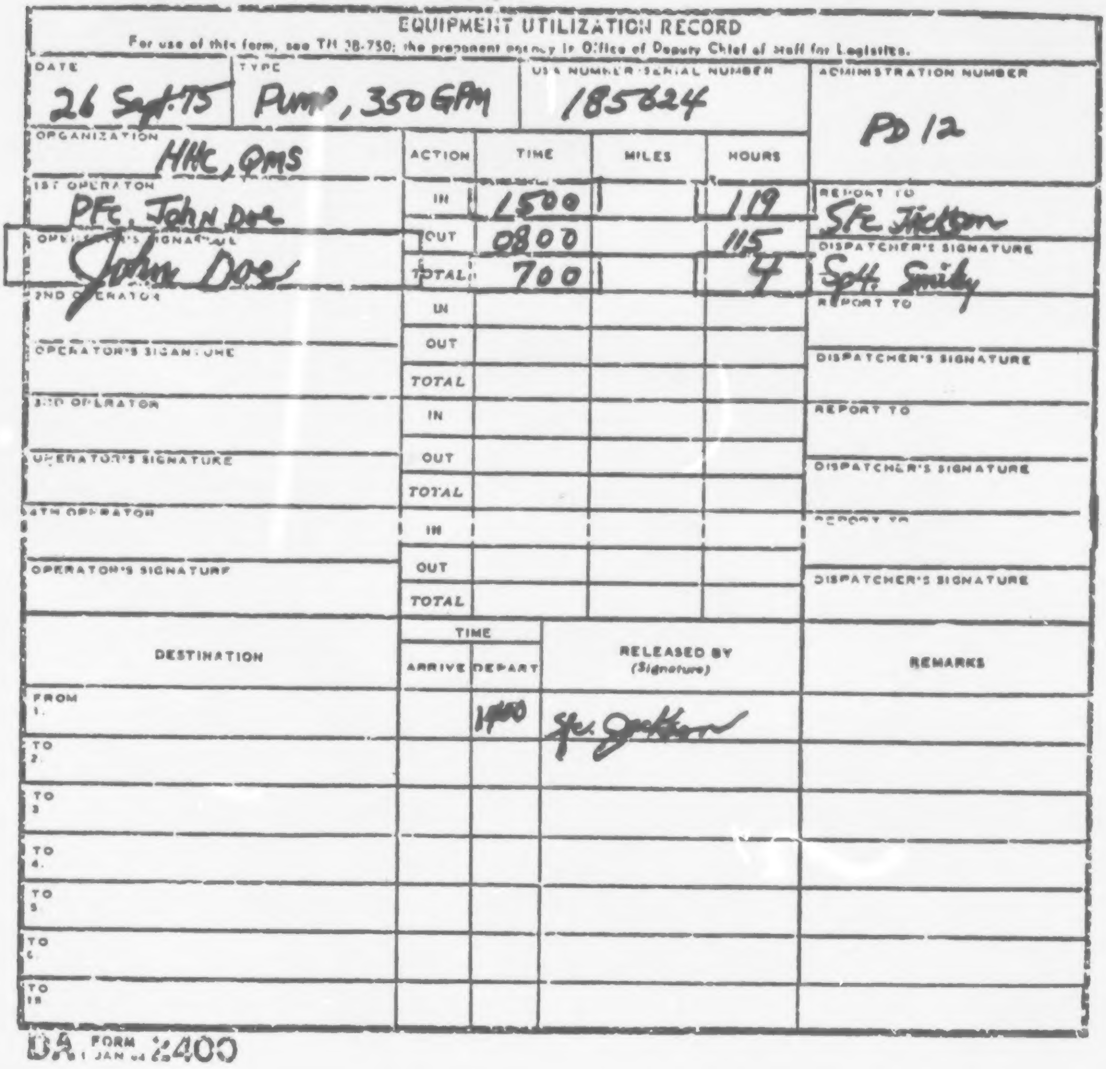
GET IT? GO ON TO THE NEXT FRAME

IF NOT - REVIEW OR CONTACT AN INSTRUCTOR

EXAMPLE

PFC Doe's supervisor released him at 1400. The pump hour meter read 119 hours. Doe arrived at 1500. After Doe completed his form it looked like the one below. All entries Doe or any operator has to make are in BOXES.

Study the form - Then flip the page.



EQUIPMENT UTILIZATION RECORD

For use of this form, see TM 38-750; the proponent agency is Office of Deputy Chief of Staff for Logistics.

DATE	TYPE	USA NUMBER-SERIAL NUMBER	ADMINISTRATION NUMBER
26 Sept. 75	Pump, 350 GPM	185624	PD 12

ORGANIZATION HHC, QMS

	ACTION	TIME	MILES	HOURS	
1ST OPERATOR PFC, John Doe	IN	1500		119	REPORT TO Sfc Jackson
OPERATOR'S SIGNATURE John Doe	OUT	0800		115	DISPATCHER'S SIGNATURE Sp4 Smity
	TOTAL	700		4	
2ND OPERATOR	IN				REPORT TO
OPERATOR'S SIGNATURE	OUT				DISPATCHER'S SIGNATURE
	TOTAL				
3RD OPERATOR	IN				REPORT TO
OPERATOR'S SIGNATURE	OUT				DISPATCHER'S SIGNATURE
	TOTAL				
4TH OPERATOR	IN				REPORT TO
OPERATOR'S SIGNATURE	OUT				DISPATCHER'S SIGNATURE
	TOTAL				

DESTINATION	TIME ARRIVE	TIME DEPART	RELEASED BY (Signature)	REMARKS
FROM 1.		1400	Sfc. Jackson	
TO 2.				
TO 3.				
TO 4.				
TO 5.				
TO 6.				
TO				

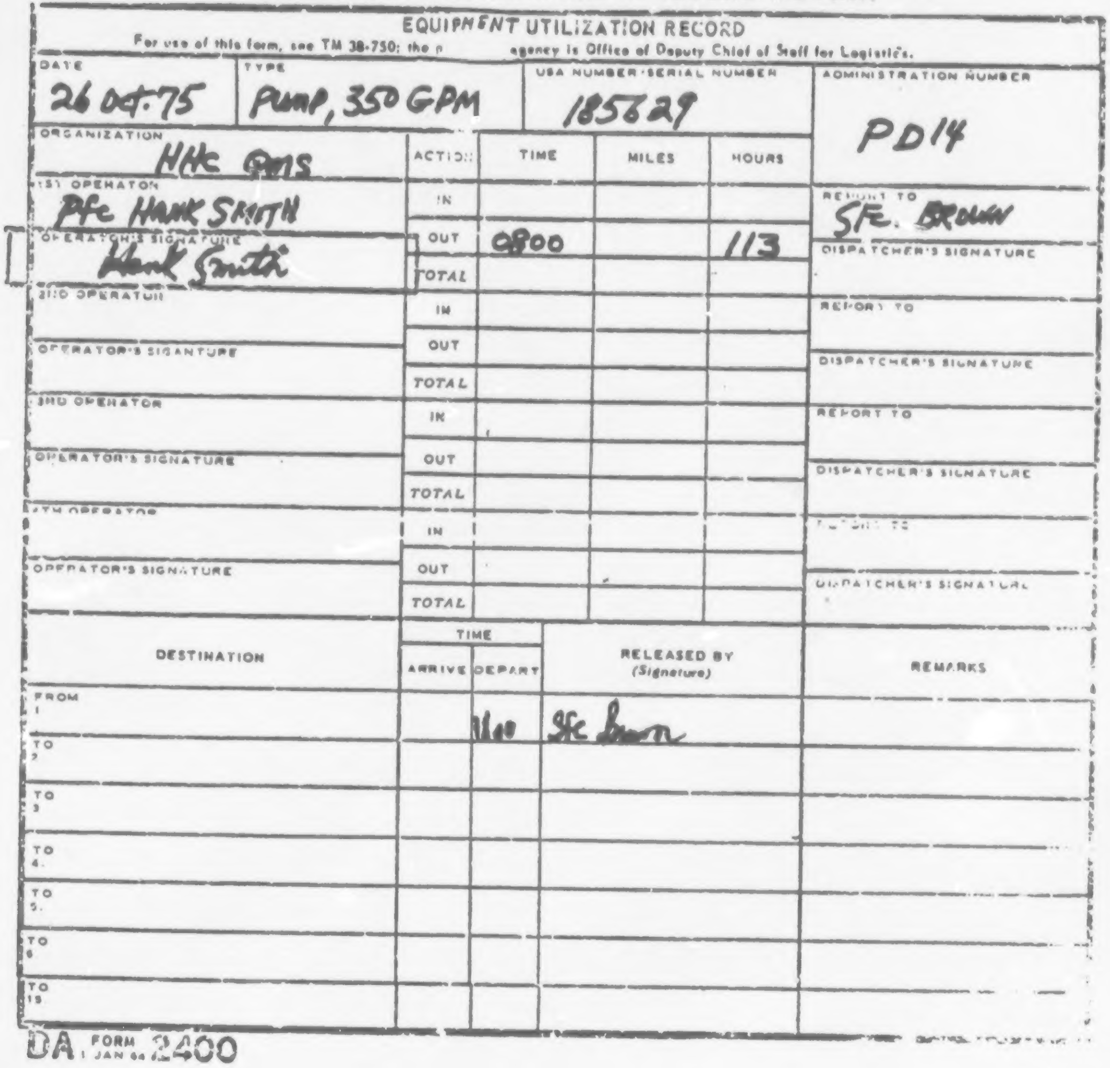
DA FORM 1 JAN 2400

GO ON TO THE NEXT PAGE

SITUATION

After he was released Smith arrived back at 1700. The hour meter on the pump read 116.

FILL IN ALL ENTRIES SMITH MADE TO COMPLETE THE FORM:



EQUIPMENT UTILIZATION RECORD

For use of this form, see TM 38-750; the p agency is Office of Deputy Chief of Staff for Logistics.

DATE	TYPE	USA NUMBER/SERIAL NUMBER	ADMINISTRATION NUMBER
26 Oct. 75	Pump, 350 GPM	185629	PD14

	ACTION	TIME	MILES	HOURS	
ORGANIZATION HHC GMS					
1ST OPERATOR Pfc HANK SMITH	IN				REPORT TO SFC. BROWN
OPERATOR'S SIGNATURE Hank Smith	OUT	0800		113	DISPATCHER'S SIGNATURE
	TOTAL				
2ND OPERATOR	IN				REPORT TO
OPERATOR'S SIGANTURE	OUT				DISPATCHER'S SIGNATURE
	TOTAL				
3RD OPERATOR	IN				REPORT TO
OPERATOR'S SIGNATURE	OUT				DISPATCHER'S SIGNATURE
	TOTAL				
4TH OPERATOR	IN				REPORT TO
OPERATOR'S SIGNATURE	OUT				DISPATCHER'S SIGNATURE
	TOTAL				

DESTINATION	TIME		RELEASED BY (Signature)	REMARKS
	ARRIVE	DEPART		
FROM 1		1100	Sfc Brown	
TO 2				
TO 3				
TO 4.				
TO 5.				
TO 6				
TO 15				

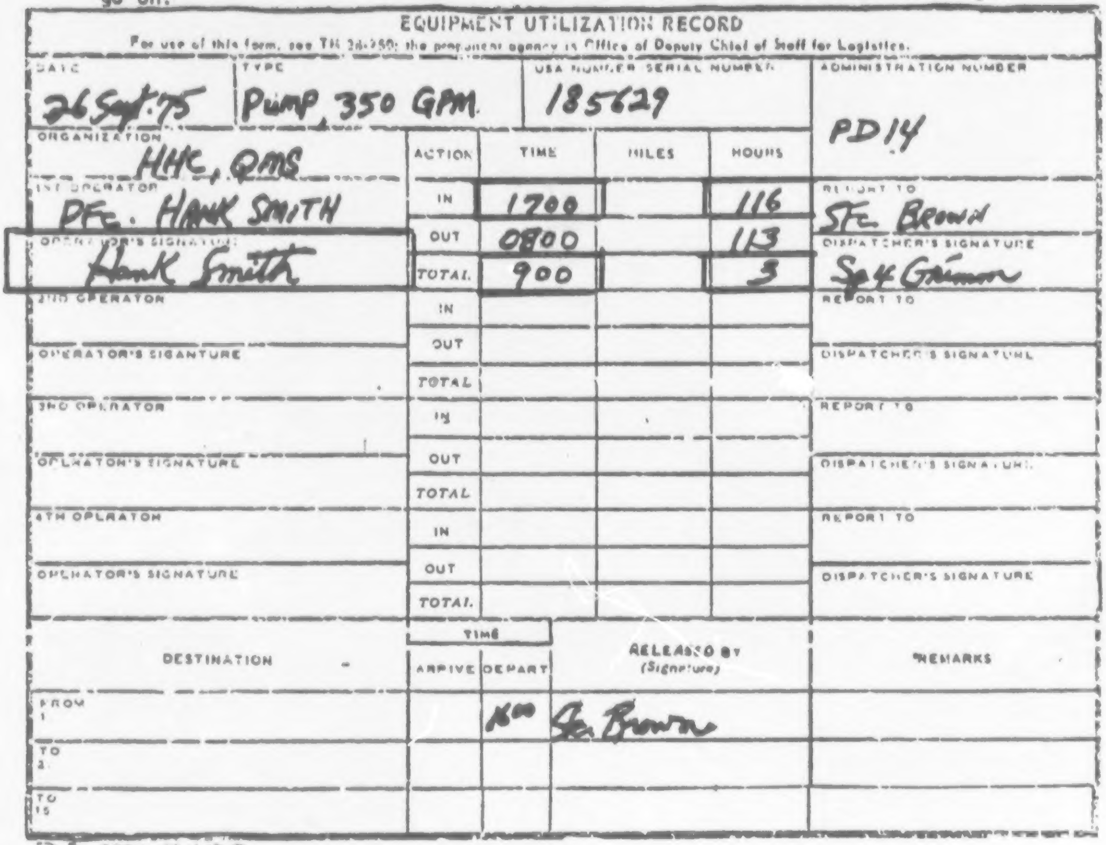
DA FORM 1 JAN 64 2400

GO ON TO THE NEXT PAGE

193

DISCUSSION

The correct entries are in BOXES on the form below.
How did you do? Check your form and read the bottom of the page before you go on.



EQUIPMENT UTILIZATION RECORD

For use of this form, see TM 38-750; the proponent agency is Office of Deputy Chief of Staff for Logistics.

DATE 26 Sept. 75	TYPE Pump, 350 GPM		USA NUMBER SERIAL NUMBER 185629		ADMINISTRATION NUMBER PD14
ORGANIZATION HHC, QMS	ACTION	TIME	MILES	HOURS	
1ST OPERATOR PFC. HANK SMITH	IN	1700		116	REPORT TO SFC. BROWN
OPERATOR'S SIGNATURE Hank Smith	OUT	0800		113	DISPATCHER'S SIGNATURE Sp4 Grimm
	TOTAL	900		3	
2ND OPERATOR	IN				REPORT TO
OPERATOR'S SIGANTURE	OUT				DISPATCHER'S SIGNATURE
	TOTAL				
3RD OPERATOR	IN				REPORT TO
OPERATOR'S SIGNATURE	OUT				DISPATCHER'S SIGNATURE
	TOTAL				
4TH OPERATOR	IN				REPORT TO
OPERATOR'S SIGNATURE	OUT				DISPATCHER'S SIGNATURE
	TOTAL				

DESTINATION	TIME ARRIVE	TIME DEPART	RELEASED BY (Signature)	REMARKS
FROM 1		1600	Sfc. Brown	
TO 2				
TO 15				

DA FORM 1 JAN 64 2400

A. The operator (76W20) is responsible for the following entries if the machine stays in one place.

1. Operator's signature block.
2. Time in and total time block.
3. Hours in and total hours block.

*B. If he operates a vehicle and moves from place to place the operator is also responsible for:

1. Destination (from and to) blocks.
2. Time (arrive/depart) blocks.

GOT IT?

REVIEW IF YOU WANT BEFORE TURNING THE PAGE

OPERATORS MUST KNOW SYMBOLS OF EQUIPMENT STATUS

THESE TAMMS FORMS REQUIRE AN ENTRY TO INDICATE EQUIPMENT STATUS } →

DA Form 2404
DA Form 2408-1
DA Form 2408-14

SYMBOLS WHICH INDICATE EQUIPMENT STATUS ARE: X, Ⓧ , /, ___

X	MEANS	UNSAFE OR INOPERABLE CONDITION
Ⓧ	MEANS	A LIMITATION OF THE EQUIPMENT'S CAPACITY (*DETERMINED BY COMMANDER)
/	MEANS	A "NICE TO HAVE" ITEM NEEDS REPAIR OR REPLACEMENT
___	MEANS	A MAINTENANCE CHECK, INSPECTION, OR SERVICE IS DUE.

FILL IN THE ANSWERS BELOW

Indicate which status symbol is appropriate for each equipment set of problems described.

_____A Preventative maintenance check due, quarterly inspection due, lubrication service due.

_____B Leaking radiator, bad headlight, broken windshield wiper.

_____C Leaking gas tank, bad brakes, broken axle, faulty steering.

_____D Torn seat cover, cracked reflector, peeling paint.

TURN PAGE FOR DISCUSSION

DISCUSSION

___ A Preventative maintenance, quarterly inspection, and lubrication are all checks and services which are required at specified times.

Ⓧ B Problems such as leaking radiators, bad headlights, or broken windshield wipers will limit equipment - but the equipment can still be used.

* NOTE: Operators will use an Ⓧ only under commander's authorization!

X C A leaking gas tank, bad brakes, broken axle or faulty steering are the types of problems that make equipment unsafe or inoperable.

/ D Seat covers, reflectors and paint are all nice to have, but do not affect the operation of equipment!

REVIEW

A. DA Forms 2404, 2408-1, 2408-14 all require a status symbol entry.

B. X, /, and ___ are entered by operators during inspection or operation.

C. Ⓧ is used only under commander's authorization.

TURN THE PAGE

CHANGE IN EQUIPMENT STATUS

Equipment status may be changed to "satisfactory" by placing last name initial over status symbol.

xB
ⓧB
/B
—B

All these status symbols have been changed by a supervisor named SFC Brown.

Check ✓ which status symbols have been changed, then turn the page.

_____A   X
_____B   ⓧ
_____C   /B
_____D   ____
_____E   xB

TURN PAGE FOR DISCUSSION

197

DISCUSSION

You should have checked c and e. Equipment status is considered satisfactory when a last name initial has been placed over the status symbol.

GOT IT? GO ON TO THE NEXT PAGE.

IF NOT - REVIEW

TAMMS

DA Form 2404 (Equipment Inspection and Maintenance Worksheet)

DA Form 2408-14 (Uncorrected Fault Record)

Operators prepare DA Form 2404 to:

a. Record all faults they cannot fix themselves when they inspect or operate equipment.

b. Record all faults that they were able to fix themselves by replacing parts.

Supervisors prepare DA Form 2408-14 in the equipment logbook to:

a. Record all faults operators could not fix reported on DA Form 2404.

b. Record all deferred maintenance reported by operators on DA Form 2404.

1. Check ✓ the form operators read and check.
   a. _______ DA Form 2404.
   b. _______ DA Form 2408-14.
2. Check ✓ the form operators make entries on.
   a. _______ DA Form 2404.
   b. _______ DA Form 2408-14.

TURN PAGE FOR DISCUSSION

DISCUSSION

1 - Answer b. The operator never prepares or writes on DA Form 2408-14. His supervisor prepares this form and you will find out why further on.

2 - Answer a. The operator prepares DA Form 2404 and turns it in at the end of the day.

DO YOU UNDERSTAND?

IF NOT - REVIEW.

IF YOU GET IT - TURN THE PAGE.

DA Form 2408-14 is prepared and kept in a logbook by your supervisor.

YOU - the operator - prepare DA Form 2404.

Each day the supervisor reads your DA Form 2404 and makes appropriate entries on the DA Form 2408-14.

JUST REMEMBER: Always check DA Form 2408-14 to see whether or not the problem has already been recorded on DA Form 2408-14 before you prepare DA Form 2404.

Situation: On 26 Sep 75 PFC John Doe was given DA Form 2404 and a logbook to operate a pump. He inspected the pump and found a cracked reflector lens.

Question: Check ✓ the action Doe should take...

_____a. Prepare DA Form 2404 to show the cracked reflector.

_____b. Check the logbook for DA Form 2408-14.

TURN THE PAGE FOR DISCUSSION

DISCUSSION

Answer: b. PFC Doe should read and check DA Form 2408-14 in the logbook BEFORE he prepares DA Form 2404. REMEMBER: The problem may already be recorded on DA Form 2408-14.

TURN THE PAGE

PROCEDURES OPERATORS SHOULD FOLLOW AFTER CHECKING DA FORM 2408-14

IF DA FORM 2408-14
LISTS THE PROBLEM → DO NOT ENTER
PROBLEM ON
DA FORM 2404.

IF DA FORM 2408-14
DOES NOT LIST
THE PROBLEM → ENTER THE PROBLEM
AND STATUS ON
DA FORM 2404.

Check ✓ what action should be taken if:

PFC Doe finds a cracked reflector, that is not entered on DA Form 2408-14.

_____a He should list the reflector on DA Form 2404.

_____b He should not list the reflector on DA Form 2404.

PFC Doe finds a broken headlight that is entered on DA Form 2408-14.

_____a He should list the headlight on DA Form 2404.

_____b He should not list the headlight on DA Form 2404.

TURN PAGE FOR DISCUSSION

DISCUSSION

1. Answer a. Doe should list the reflector on DA Form 2404 because it is not listed in the logbook on DA Form 2408-14.

2. Answer b. Doe should not list the headlight on DA Form 2404 if it has already been listed on DA Form 2408-14.

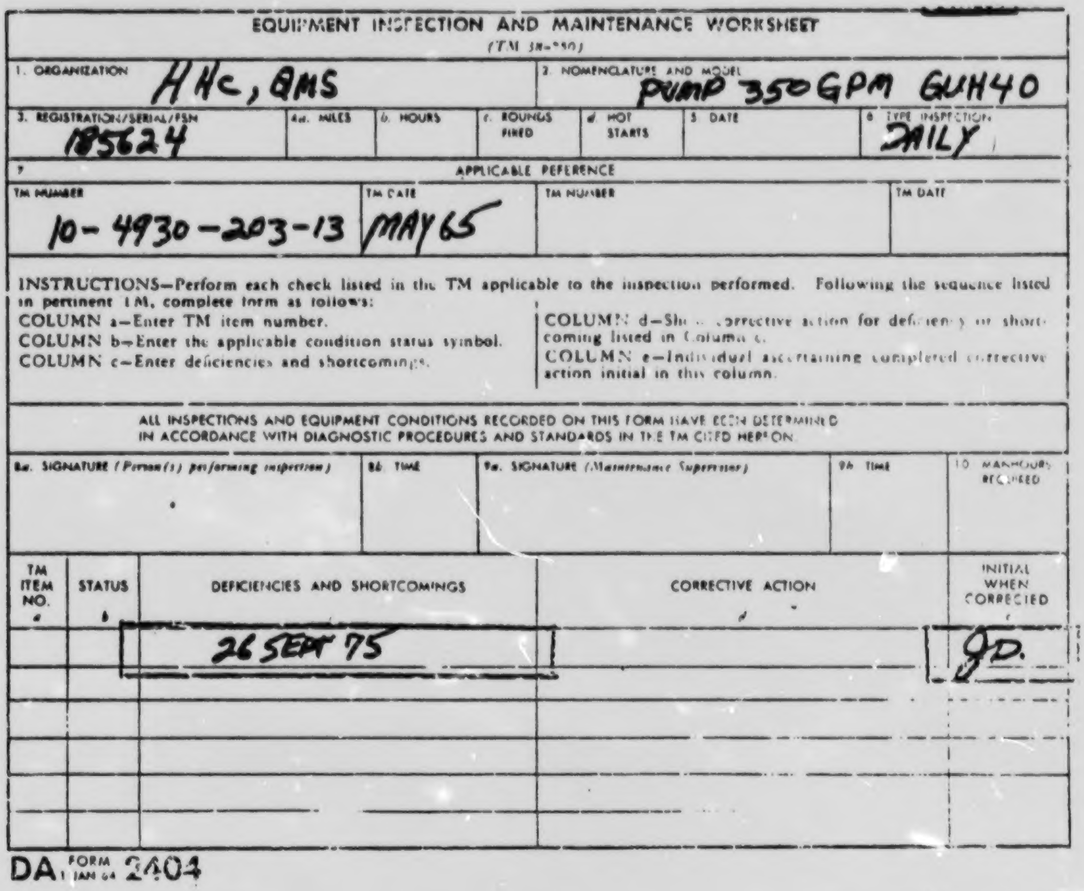
GO ON TO THE NEXT PAGE

EXAMPLE - Study the form below.

On 26 September 1975, PFC John Doe was given a DA Form 2404 and logbook to operate a pump. During inspection the only problem he found that he could not fix was a bent tow bar (TM Item No. 8). The pump had 198 hours.

First, PFC Doe checked the logbook for DA Form 2408-14. He saw the bent towbar had already been noted.

Then - he prepared DA Form 2404, as shown below. His entries are in BOXES.



EQUIPMENT INSPECTION AND MAINTENANCE WORKSHEET
(TM 38-750)

1. ORGANIZATION HHc, QMS				2. NOMENCLATURE AND MODEL PUMP 350GPM GUH40		
3. REGISTRATION/SERIAL/FSN 185624	4a. MILES	b. HOURS	c. ROUNDS FIRED	d. HOT STARTS	5. DATE	6. TYPE INSPECTION DAILY

7 APPLICABLE REFERENCE

TM NUMBER 10-4930-203-13	TM DATE MAY 65	TM NUMBER	TM DATE

INSTRUCTIONS—Perform each check listed in the TM applicable to the inspection performed. Following the sequence listed in pertinent TM, complete form as follows:
COLUMN a—Enter TM item number.
COLUMN b—Enter the applicable condition status symbol.
COLUMN c—Enter deficiencies and shortcomings.
COLUMN d—Show corrective action for deficiency or shortcoming listed in Column c.
COLUMN e—Individual ascertaining completed corrective action initial in this column.

ALL INSPECTIONS AND EQUIPMENT CONDITIONS RECORDED ON THIS FORM HAVE BEEN DETERMINED IN ACCORDANCE WITH DIAGNOSTIC PROCEDURES AND STANDARDS IN THE TM CITED HEREON.

8a. SIGNATURE (Person(s) performing inspection)	8b. TIME	9a. SIGNATURE (Maintenance Supervisor)	9b. TIME	10. MANHOURS REQUIRED

TM ITEM NO. a	STATUS b	DEFICIENCIES AND SHORTCOMINGS c	CORRECTIVE ACTION d	INITIAL WHEN CORRECTED e
		26 SEPT 75		JD.

DA FORM 1 JAN 64 2404

GO ON TO THE NEXT PAGE

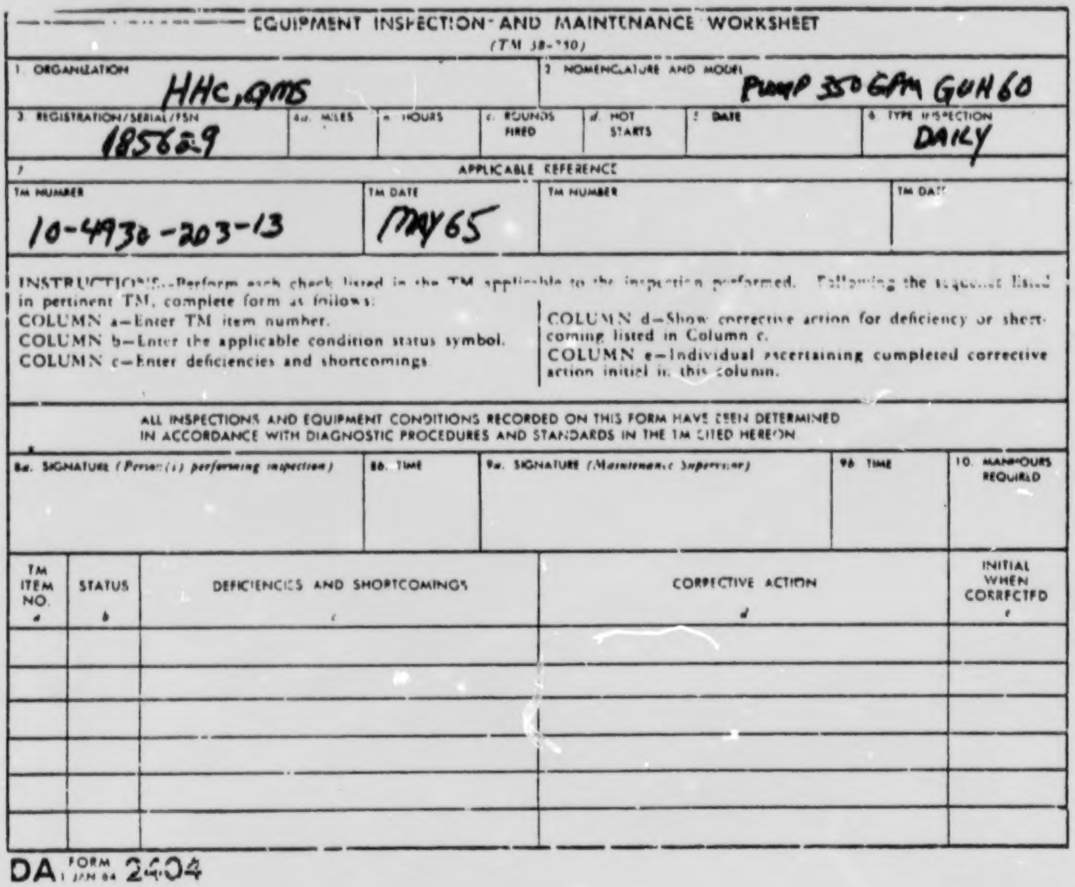
SITUATION

On 26 September 1975, PFC Hank Smith was given a DA Form 2404 and logbook and ordered to operate a pump. During inspection he found a cracked reflector lens (TM Item No. 6). The pump hour dial read 179..

First, Smith checked DA Form 2408-14 in the pump's logbook. The cracked reflector had been entered.

Next, Smith prepared DA Form 2404.

FILL IN THE ENTRIES PFC SMITH MADE - THEN TURN THE PAGE



EQUIPMENT INSPECTION AND MAINTENANCE WORKSHEET
(TM 38-750)

1. ORGANIZATION HHc, QMS	2. NOMENCLATURE AND MODEL PUMP 350 GPM GUH60

3. REGISTRATION/SERIAL/FSN 185629	4a. MILES	b. HOURS	c. ROUNDS FIRED	d. HOT STARTS	5. DATE	6. TYPE INSPECTION DAILY

7. APPLICABLE REFERENCE

TM NUMBER	TM DATE	TM NUMBER	TM DATE
10-4930-203-13	MAY 65		

INSTRUCTIONS--Perform each check listed in the TM applicable to the inspection performed. Following the sequence listed in pertinent TM, complete form as follows:

COLUMN a—Enter TM item number.
COLUMN b—Enter the applicable condition status symbol.
COLUMN c—Enter deficiencies and shortcomings.
COLUMN d—Show corrective action for deficiency or shortcoming listed in Column c.
COLUMN e—Individual ascertaining completed corrective action initial in this column.

ALL INSPECTIONS AND EQUIPMENT CONDITIONS RECORDED ON THIS FORM HAVE BEEN DETERMINED IN ACCORDANCE WITH DIAGNOSTIC PROCEDURES AND STANDARDS IN THE TM CITED HEREON.

8a. SIGNATURE (Person(s) performing inspection)	8b. TIME	9a. SIGNATURE (Maintenance Supervisor)	9b. TIME	10. MANHOURS REQUIRED

TM ITEM NO. a	STATUS b	DEFICIENCIES AND SHORTCOMINGS c	CORRECTIVE ACTION d	INITIAL WHEN CORRECTED e

DA FORM 1 JAN 64 2404

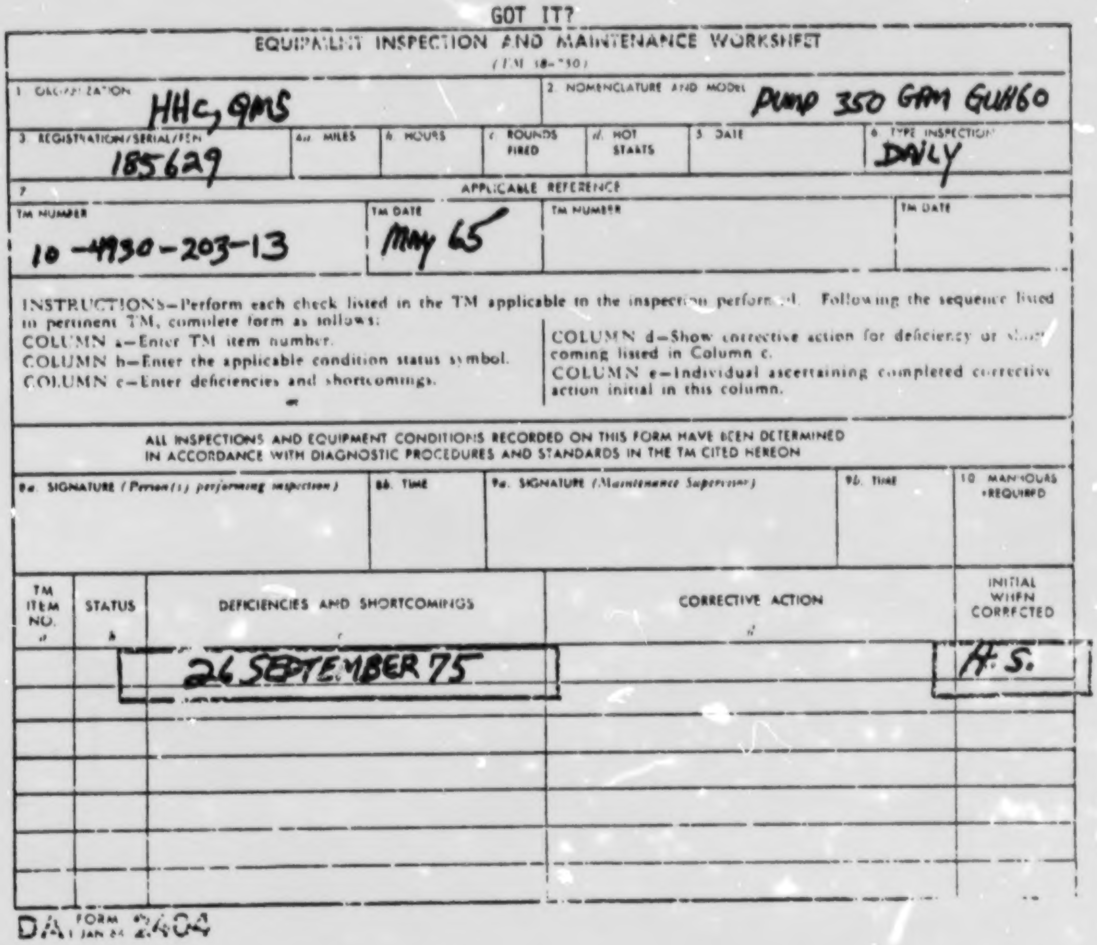
TURN PAGE FOR DISCUSSION

DISCUSSION: DA FORM 2404

Smith filled in columns c and e at the bottom. Because the reflector had been already reported and noted on DA Form 2408-14 Smith only had to put the correct date in column c and his initials in column e.

The correct entries are in BOXES.

GOT IT?



EQUIPMENT INSPECTION AND MAINTENANCE WORKSHEET
(TM 38-750)

1. ORGANIZATION: HHC, QMS
2. NOMENCLATURE AND MODEL: PUMP 350 GAM GUH60
3. REGISTRATION/SERIAL/FSN: 185629
4a. MILES:
b. HOURS:
c. ROUNDS FIRED:
d. HOT STARTS:
5. DATE:
6. TYPE INSPECTION: DAILY
7. APPLICABLE REFERENCE

TM NUMBER	TM DATE	TM NUMBER	TM DATE
10-4930-203-13	May 65		

INSTRUCTIONS—Perform each check listed in the TM applicable to the inspection performed. Following the sequence listed in pertinent TM, complete form as follows:
COLUMN a—Enter TM item number.
COLUMN b—Enter the applicable condition status symbol.
COLUMN c—Enter deficiencies and shortcomings.
COLUMN d—Show corrective action for deficiency or shortcoming listed in Column c.
COLUMN e—Individual ascertaining completed corrective action initial in this column.

ALL INSPECTIONS AND EQUIPMENT CONDITIONS RECORDED ON THIS FORM HAVE BEEN DETERMINED IN ACCORDANCE WITH DIAGNOSTIC PROCEDURES AND STANDARDS IN THE TM CITED HEREON

8a. SIGNATURE (Person(s) performing inspection):
8b. TIME:
9a. SIGNATURE (Maintenance Supervisor):
9b. TIME:
10. MANHOURS REQUIRED:

TM ITEM NO. a	STATUS b	DEFICIENCIES AND SHORTCOMINGS c	CORRECTIVE ACTION d	INITIAL WHEN CORRECTED e
		26 SEPTEMBER 75		A.S.

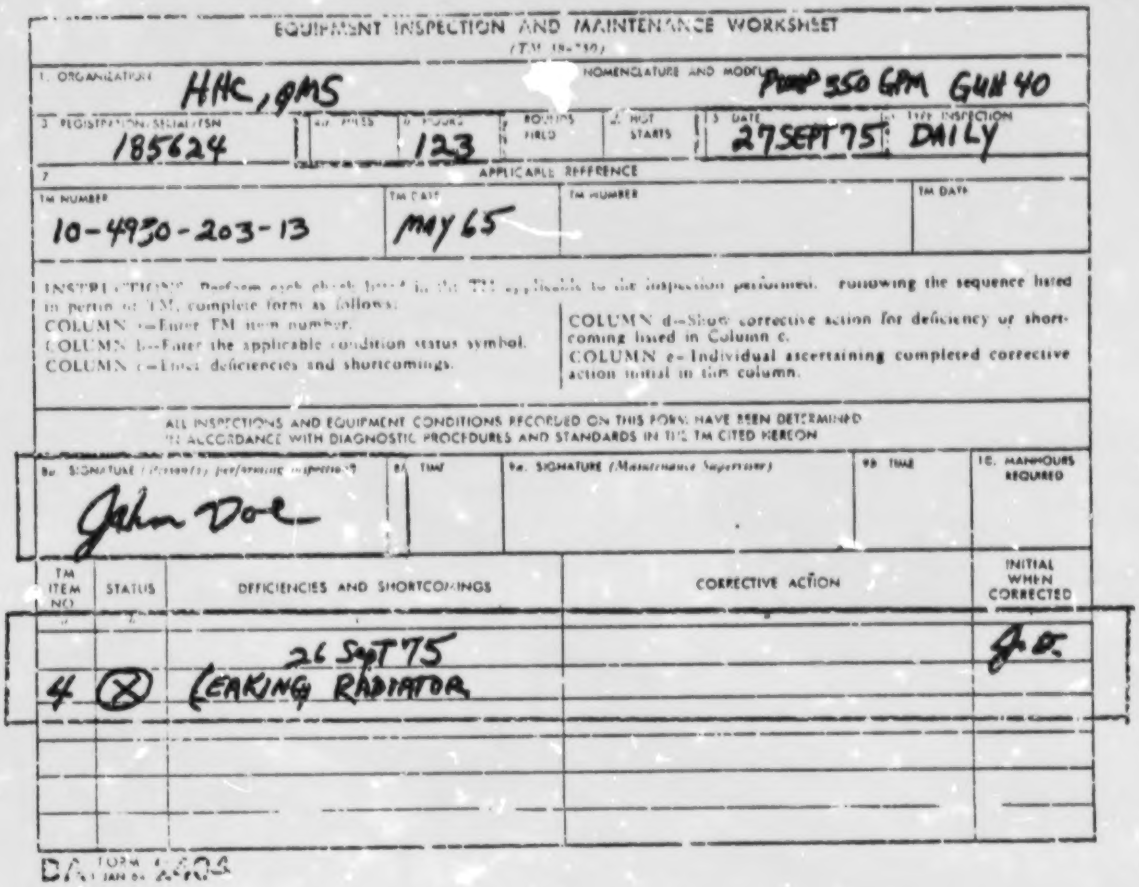
DA FORM 2404, 1 JAN 64

TURN THE PAGE

EXAMPLE

On 27 Sept 75. PFC Doe found a leaking radiator when inspecting a pump. He could not fix the leak. The radiator TM Item No is 4. The pump can be operated for limited periods with the leaking radiator. Doe entered status symbol X to show limited use. The hour meter read 203.

DA Form 2408-14 did not list the problem.
PFC Doe's entries are in the BOXES .
After Doe prepared his DA Form 2404 it looked like the form below.



EQUIPMENT INSPECTION AND MAINTENANCE WORKSHEET
(TM 38-750)

1. ORGANIZATION HHC, GMS
2. NOMENCLATURE AND MODEL Pump 350 GPM GUN 40
3. REGISTRATION/SERIAL/FSN 185624
4a. MILES
4b. HOURS 123
4c. ROUNDS FIRED
4d. HOT STARTS
5. DATE 27SEPT75
6. TYPE INSPECTION DAILY

7. APPLICABLE REFERENCE

TM NUMBER	TM DATE	TM NUMBER	TM DATE
10-4930-203-13	MAY 65		

INSTRUCTIONS: Perform each check listed in the TM applicable to the inspection performed. Following the sequence listed in portion of TM, complete form as follows:
COLUMN a—Enter TM item number.
COLUMN b—Enter the applicable condition status symbol.
COLUMN c—Enter deficiencies and shortcomings.
COLUMN d—Show corrective action for deficiency or shortcoming listed in Column c.
COLUMN e—Individual ascertaining completed corrective action initial in this column.

ALL INSPECTIONS AND EQUIPMENT CONDITIONS RECORDED ON THIS FORM HAVE BEEN DETERMINED IN ACCORDANCE WITH DIAGNOSTIC PROCEDURES AND STANDARDS IN THE TM CITED HEREON

8a. SIGNATURE (Person(s) performing inspection) John Doe
8b. TIME
9a. SIGNATURE (Maintenance Supervisor)
9b. TIME
10. MANHOURS REQUIRED

TM ITEM NO	STATUS	DEFICIENCIES AND SHORTCOMINGS	CORRECTIVE ACTION	INITIAL WHEN CORRECTED
a	b	c	d	e
		26 Sept 75		J.D.
4	⊗	LEAKING RADIATOR		

DA FORM 2404, 1 JAN 64

TURN THE PAGE

SITUATION

On 27 Oct 75, PFC Hank Smith was given a logbook and DA Form 2404 to operate a pump (there were 99 hours on the pump). The pump had a cracked reflector lens (TM Item No. 6). Smith could not replace the reflector, which is a nice to have item. DA Form 2408-14 had no entry for the problem.

FILL IN THE ENTRIES SMITH MADE - THEN FLIP THE PAGE.

EQUIPMENT INSPECTION AND MAINTENANCE WORKSHEET

(TM 38-750)

1. ORGANIZATION HHC, QMS
2. NOMENCLATURE AND MODEL PUMP 350 GPM GOH60
3. REGISTRATION/SERIAL/SN 185629
4a. MILES
b. HOURS
c. ROUNDS FIRED
d. HOT STARTS
5. DATE
6. TYPE INSPECTION DAILY

7. APPLICABLE REFERENCE

TM NUMBER	TM DATE	TM NUMBER	TM DATE
10-4930-203-13	MAY65		

INSTRUCTIONS—Perform each check listed in the TM applicable to the inspection performed. Following the sequence listed in pertinent TM, complete form as follows:

COLUMN a—Enter TM item number

COLUMN b—Enter the applicable condition status symbol.

COLUMN c—Enter deficiencies and shortcomings.

COLUMN d—Show corrective action for deficiency or shortcoming listed in Column c.

COLUMN e—Individual ascertaining completed corrective action initial in this column.

ALL INSPECTIONS AND EQUIPMENT CONDITIONS RECORDED ON THIS FORM HAVE BEEN DETERMINED IN ACCORDANCE WITH DIAGNOSTIC PROCEDURES AND STANDARDS IN THE TM CITED HEREON

8a. SIGNATURE (Person(s) performing inspection)	8b. TIME	9a. SIGNATURE (Maintenance Supervisor)	9b. TIME	10. MANHOURS REQUIRED

TM ITEM NO a	STATUS b	DEFICIENCIES AND SHORTCOMINGS c	CORRECTIVE ACTION d	INITIAL WHEN CORRECTED e
		26 SEPTEMBER 75		H.S.

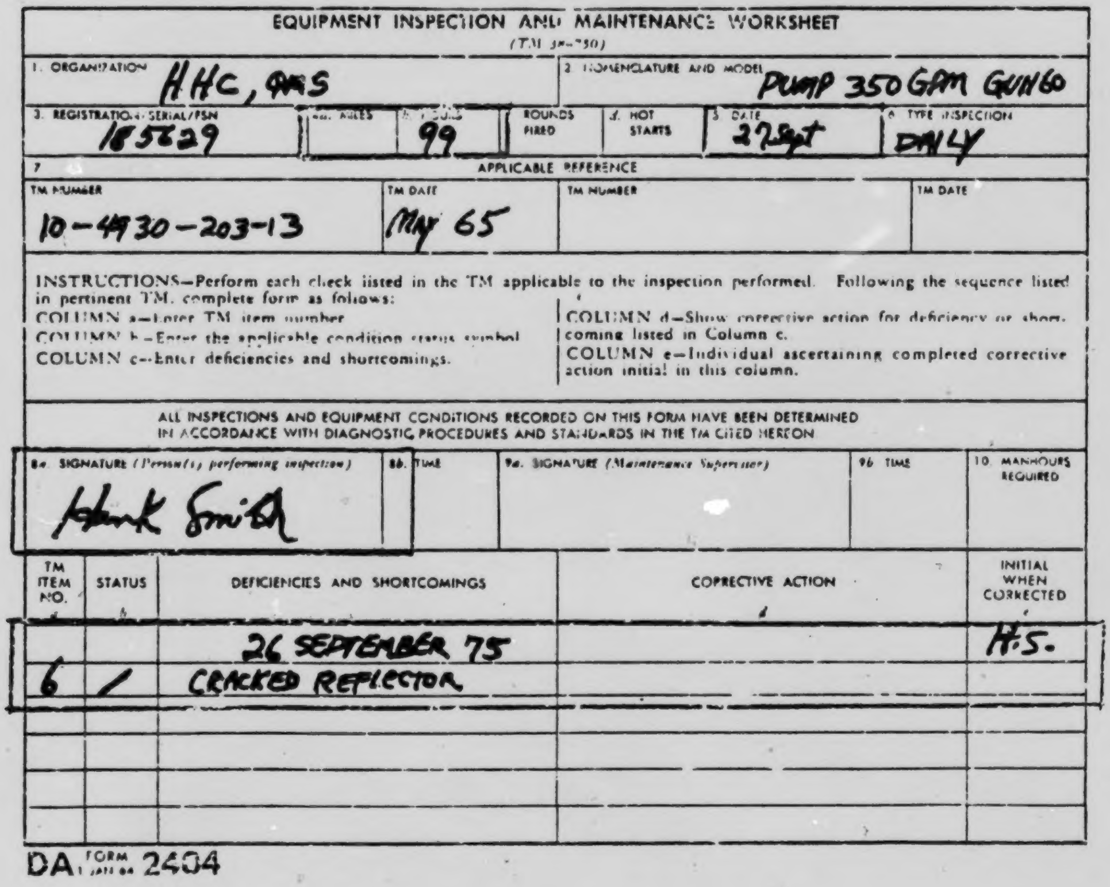
DA FORM JAN 64 2404

GO TO NEXT PAGE FOR DISCUSSION

DISCUSSION

Because DA Form 2408-14 did not list the problems, Smith completed DA Form 2404 to show the problem. The correct entries are in boxes. He prepared DA Form 2404 as follows:

Block 4b - Hour reading from pump.
Block 5 - Correct date.
Block 8a - Operators signature.
Columns a, b, c, d, e - To show all problems and the actions performed by the operator.



EQUIPMENT INSPECTION AND MAINTENANCE WORKSHEET
(TM 38-750)

1. ORGANIZATION HHC, 4RS
2. NOMENCLATURE AND MODEL PUMP 350 GPM GUN 60
3. REGISTRATION/SERIAL/FSN 185629
4a. MILES
4b. HOURS 99
c. ROUNDS FIRED
d. HOT STARTS
5. DATE 27 Sept
6. TYPE INSPECTION DAILY

7. APPLICABLE REFERENCE
TM NUMBER 10-4930-203-13
TM DATE May 65
TM NUMBER
TM DATE

INSTRUCTIONS—Perform each check listed in the TM applicable to the inspection performed. Following the sequence listed in pertinent TM, complete form as follows:
COLUMN a—Enter TM item number.
COLUMN b—Enter the applicable condition status symbol.
COLUMN c—Enter deficiencies and shortcomings.
COLUMN d—Show corrective action for deficiency or shortcoming listed in Column c.
COLUMN e—Individual ascertaining completed corrective action initial in this column.

ALL INSPECTIONS AND EQUIPMENT CONDITIONS RECORDED ON THIS FORM HAVE BEEN DETERMINED IN ACCORDANCE WITH DIAGNOSTIC PROCEDURES AND STANDARDS IN THE TM CITED HEREON

8a. SIGNATURE (Person(s) performing inspection) Hank Smith
8b. TIME
9a. SIGNATURE (Maintenance Supervisor)
9b. TIME
10. MANHOURS REQUIRED

TM ITEM NO. a	STATUS b	DEFICIENCIES AND SHORTCOMINGS c	CORRECTIVE ACTION d	INITIAL WHEN CORRECTED e
		26 SEPTEMBER 75		H.S.
6	/	CRACKED REFLECTOR		

DA FORM 2404

Status symbol / because cracked reflector is a nice to have item.

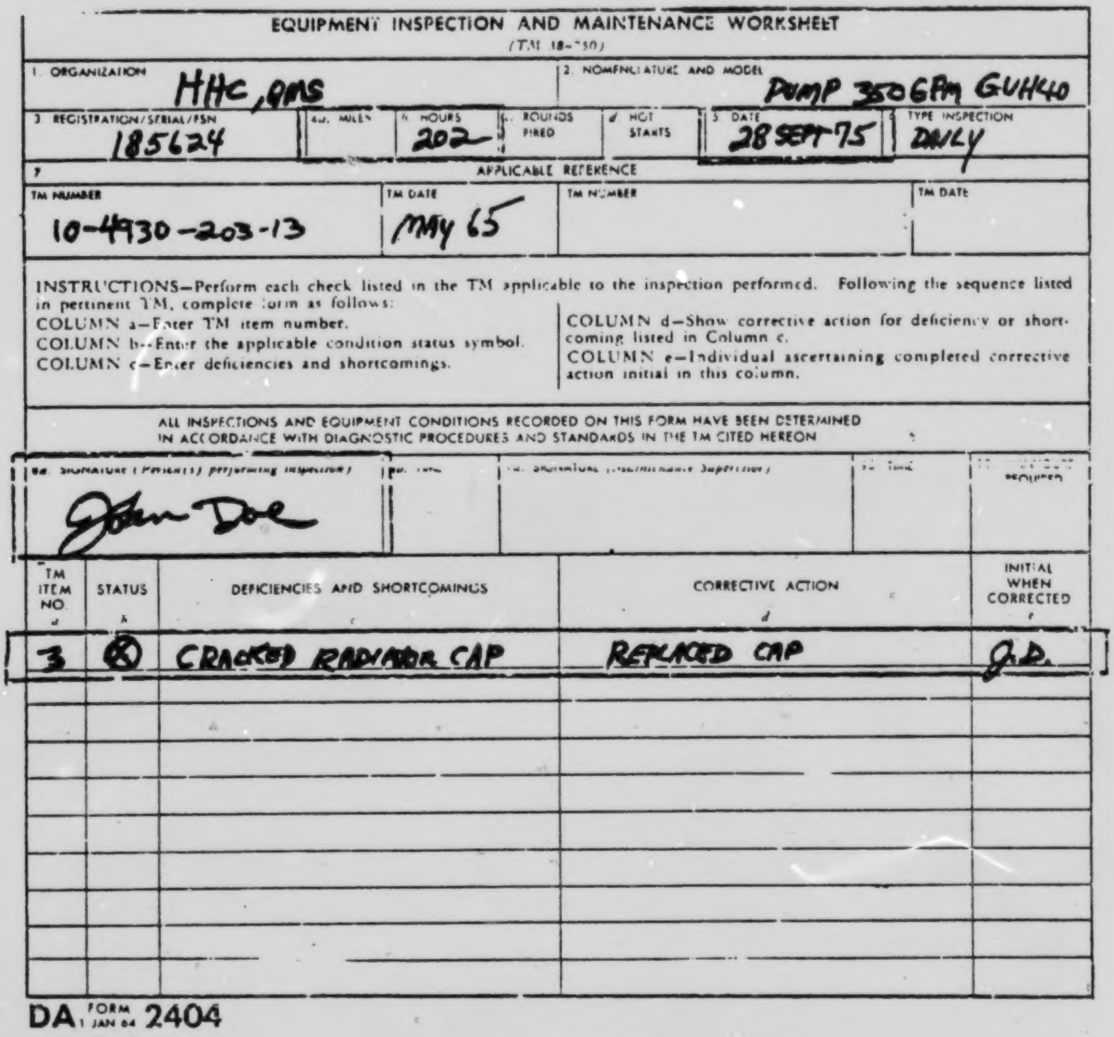
DO YOU UNDERSTAND?

REVIEW IF NECESSARY BEFORE GOING ON

EXAMPLE:

On 28 Sep 75, PFC John Doe was given a logbook and DA Form 2404 to operate a pump. The pump had a cracked radiator cap (TM Item No. 3). DA Form 2408-14 had no entry for a cracked radiator cap. Doe was able to fix the cap. The pump had 202 hours.

Doe prepared DA Form 2404. His entries are in BOXES on the form below.



EQUIPMENT INSPECTION AND MAINTENANCE WORKSHEET
(TM 38-750)

1. ORGANIZATION HHC, GMS	2. NOMENCLATURE AND MODEL PUMP 350GPM GUH40

3. REGISTRATION/SERIAL/FSN 185624	4a. MILES	b. HOURS 202	c. ROUNDS FIRED	d. HOT STARTS	5. DATE 28 SEPT 75	6. TYPE INSPECTION DAILY

7. APPLICABLE REFERENCE

TM NUMBER	TM DATE	TM NUMBER	TM DATE
10-4930-203-13	MAY 65		

INSTRUCTIONS—Perform each check listed in the TM applicable to the inspection performed. Following the sequence listed in pertinent TM, complete form as follows:

COLUMN a—Enter TM item number.
COLUMN b—Enter the applicable condition status symbol.
COLUMN c—Enter deficiencies and shortcomings.
COLUMN d—Show corrective action for deficiency or shortcoming listed in Column c.
COLUMN e—Individual ascertaining completed corrective action initial in this column.

ALL INSPECTIONS AND EQUIPMENT CONDITIONS RECORDED ON THIS FORM HAVE BEEN DETERMINED IN ACCORDANCE WITH DIAGNOSTIC PROCEDURES AND STANDARDS IN THE TM CITED HEREON

8a. SIGNATURE (Person(s) performing inspection) John Doe	8b. TIME	9a. SIGNATURE (Maintenance Supervisor)	9b. TIME	10. MANHOURS REQUIRED

TM ITEM NO. a	STATUS b	DEFICIENCIES AND SHORTCOMINGS c	CORRECTIVE ACTION d	INITIAL WHEN CORRECTED e
3	⊗	CRACKED RADIATOR CAP	REPLACED CAP	J.D.

DA FORM 1 JAN 64 2404

GO ON TO THE NEXT PAGE

SITUATION:

On 28 Oct 75, PFC Hank Smith was given a DA Form 2404 and logbook to operate a pump. The pump had a cracked reflector (TM Item No. 9). There was no entry for a cracked reflector on DA Form 2408-14. Smith made the repair of this item (a nice to have item). The hour meter read 181 hours.

USE THE FORM BELOW TO FILL IN THE ENTRIES SMITH MADE

After you complete the form turn the page to check your answer.

EQUIPMENT INSPECTION AND MAINTENANCE WORKSHEET
(TM 38-750)

1. ORGANIZATION HHC QMS
2. NOMENCLATURE AND MODEL PUMP 350GPM GUW 60
3. REGISTRATION/SERIAL/FSN 185629
4a. MILES
b. HOURS
c. ROUNDS FIRED
d. HOT STARTS
5. DATE
6. TYPE INSPECTION DAILY

7. APPLICABLE REFERENCE

TM NUMBER	TM DATE	TM NUMBER	TM DATE
10-4930-203-13	MAY 65		

INSTRUCTIONS—Perform each check listed in the TM applicable to the inspection performed. Following the sequence listed in pertinent TM, complete form as follows:
COLUMN a—Enter TM item number.
COLUMN b—Enter the applicable condition status symbol.
COLUMN c—Enter deficiencies and shortcomings.
COLUMN d—Show corrective action for deficiency or shortcoming listed in Column c.
COLUMN e—Individual ascertaining completed corrective action initial in this column.

ALL INSPECTIONS AND EQUIPMENT CONDITIONS RECORDED ON THIS FORM HAVE BEEN DETERMINED IN ACCORDANCE WITH DIAGNOSTIC PROCEDURES AND STANDARDS IN THE TM CITED HEREON

8a. SIGNATURE (Individual performing inspection)
8b. TIME
9a. SIGNATURE (Maintenance Supervisor)
9b. TIME
10. MANHOURS REQUIRED

TM ITEM NO a	STATUS b	DEFICIENCIES AND SHORTCOMINGS c	CORRECTIVE ACTION d	INITIAL WHEN CORRECTED e

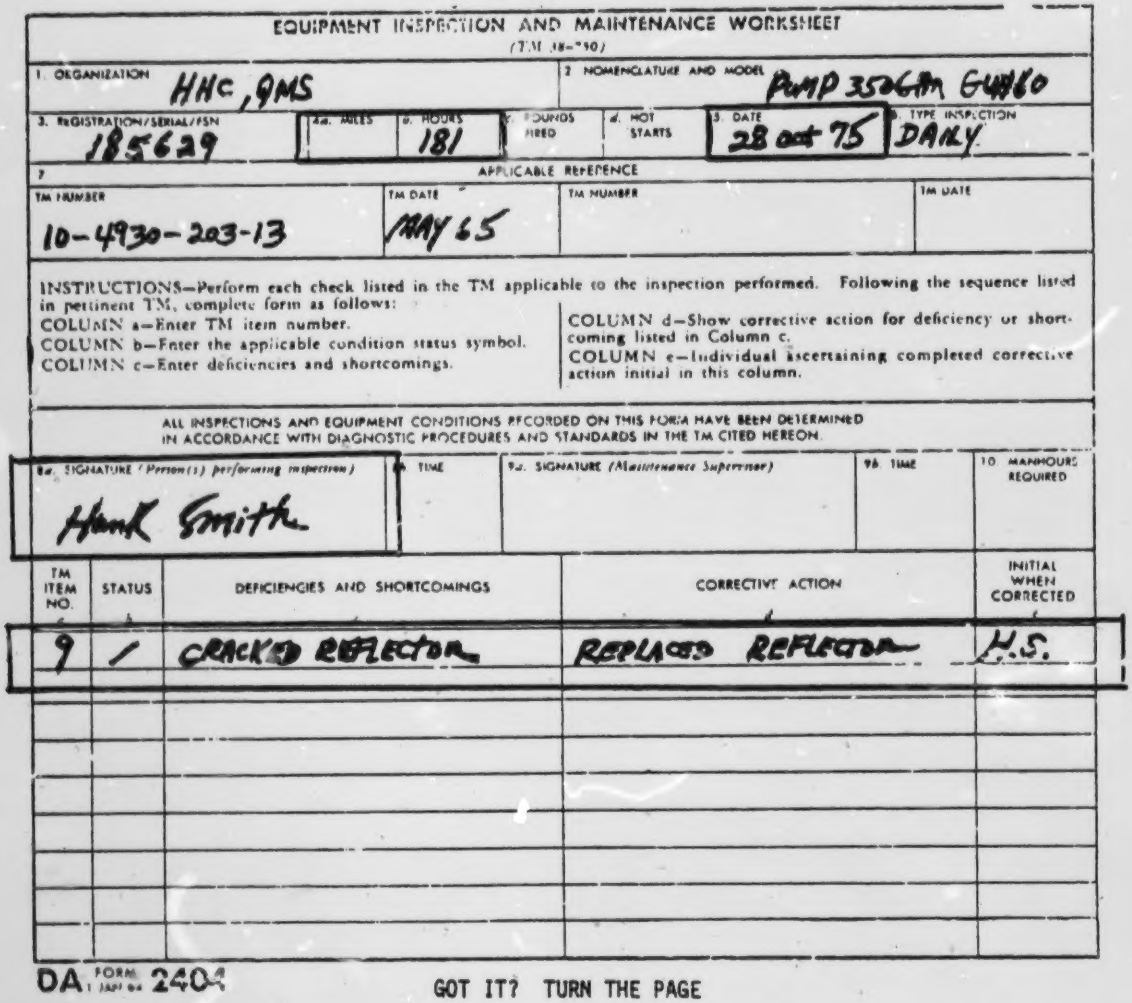
DA FORM 1 JAN 64 2404

TURN PAGE FOR DISCUSSION

DISCUSSION

Because DA Form 2408-14 did not list the problems, Smith completed DA Form 2404 as follows: The correct entries are in BOXES.

Block 4b - Hour reading from pump.
Block 5 - Correct date.
Block 8a - Operator's signature.
Columns a, b, c, d, e - To show all problems and actions performed by the operator. In this case only a, b, and c.



EQUIPMENT INSPECTION AND MAINTENANCE WORKSHEET
(TM 38-750)

1. ORGANIZATION: HHC, QMS
2. NOMENCLATURE AND MODEL: PUMP 350GPM GWH60
3. REGISTRATION/SERIAL/FSN: 185629
4a. MILES:
b. HOURS: 181
c. ROUNDS FIRED:
d. HOT STARTS:
5. DATE: 28 oct 75
6. TYPE INSPECTION: DAILY

7. APPLICABLE REFERENCE

TM NUMBER	TM DATE	TM NUMBER	TM DATE
10-4930-203-13	MAY 65		

INSTRUCTIONS—Perform each check listed in the TM applicable to the inspection performed. Following the sequence listed in pertinent TM, complete form as follows:
COLUMN a—Enter TM item number.
COLUMN b—Enter the applicable condition status symbol.
COLUMN c—Enter deficiencies and shortcomings.
COLUMN d—Show corrective action for deficiency or shortcoming listed in Column c.
COLUMN e—Individual ascertaining completed corrective action initial in this column.

ALL INSPECTIONS AND EQUIPMENT CONDITIONS RECORDED ON THIS FORM HAVE BEEN DETERMINED IN ACCORDANCE WITH DIAGNOSTIC PROCEDURES AND STANDARDS IN THE TM CITED HEREON.

8a. SIGNATURE (Person(s) performing inspection): Hank Smith
8b. TIME:
9a. SIGNATURE (Maintenance Supervisor):
9b. TIME:
10. MANHOURS REQUIRED:

TM ITEM NO.	STATUS	DEFICIENCIES AND SHORTCOMINGS	CORRECTIVE ACTION	INITIAL WHEN CORRECTED
a	b	c	d	e
9	/	CRACKED REFLECTOR	REPLACED REFLECTOR	H.S.

DA FORM 1 JAN 64 2404

GOT IT? TURN THE PAGE

208

NO? REVIEW

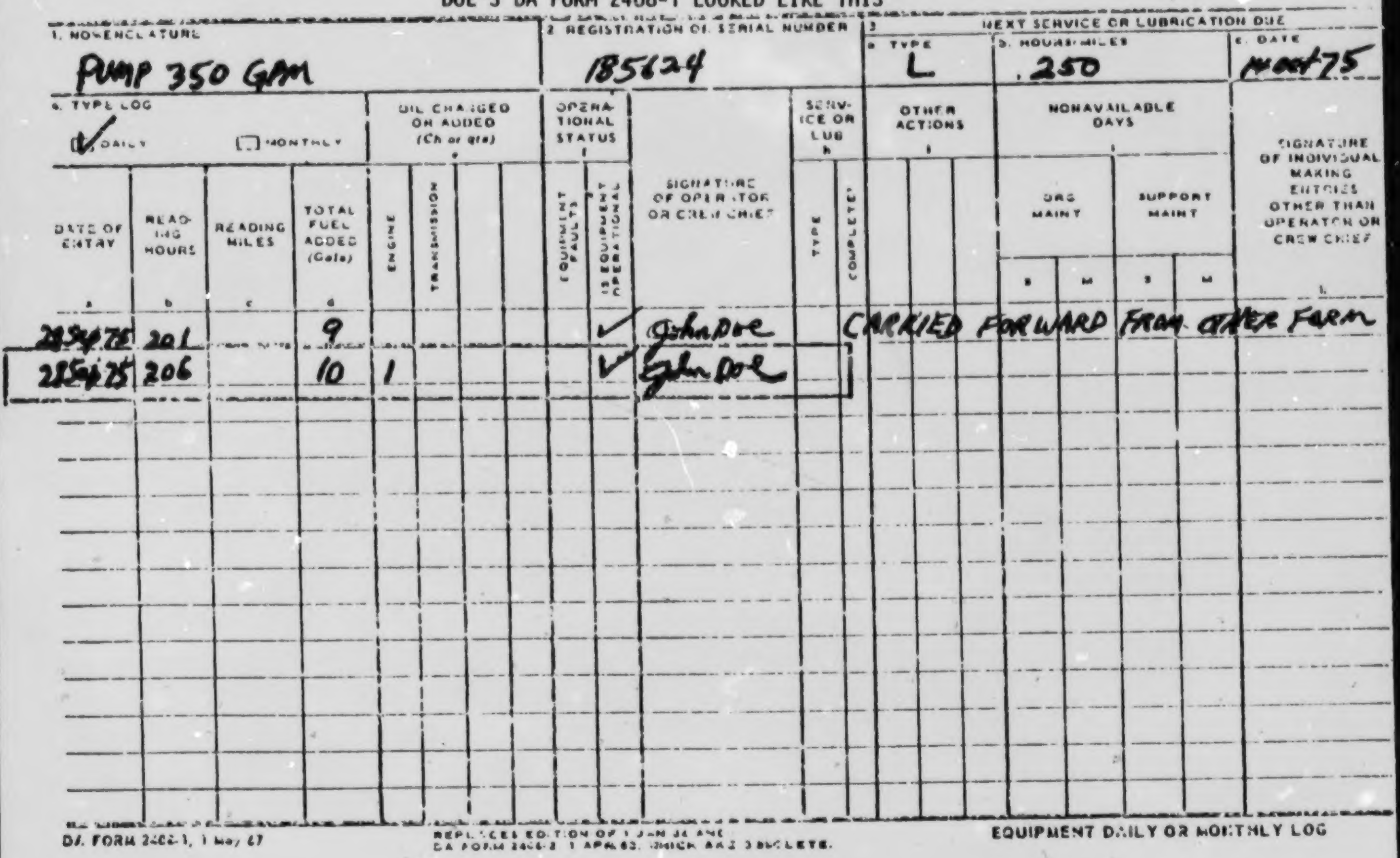
TAMMS

DA FORM 2408-1 (EQUIPMENT DAILY OR MONTHLY LOG)

EXAMPLE:

On 29 Sep 75, PFC John Doe operated a pump. He was given all TAMMS forms, including DA Form 2408-1. Doe operated the pump without problem and finished with 206 hours on the pump. He added one quart of oil and ten gallons of gas.

DOE'S DA FORM 2408-1 LOOKED LIKE THIS



1. NOMENCLATURE: PUMP 350 GPM
2. REGISTRATION OR SERIAL NUMBER: 185624
3. NEXT SERVICE OR LUBRICATION DUE — a. TYPE: L — b. HOURS/MILES: 250 — c. DATE: 14Oct75
4. TYPE LOG: ☑ DAILY ☐ MONTHLY

DATE OF ENTRY a	READING HOURS b	READING MILES c	TOTAL FUEL ADDED (Gals) d	OIL CHANGED OR ADDED (Ch or qts) e ENGINE	TRANSMISSION			OPERATIONAL STATUS f EQUIPMENT FAULTS	IS EQUIPMENT OPERATIONAL	SIGNATURE OF OPERATOR OR CREW CHIEF	SERVICE OR LUB h TYPE	COMPLETED	OTHER ACTIONS i			NONAVAILABLE DAYS j ORG MAINT S	M	SUPPORT MAINT S	M	SIGNATURE OF INDIVIDUAL MAKING ENTRIES OTHER THAN OPERATOR OR CREW CHIEF k
28Sep75	201		9						✓	John Doe			CARRIED FORWARD FROM OTHER FORM							
29Sep75	206		10	1					✓	John Doe										

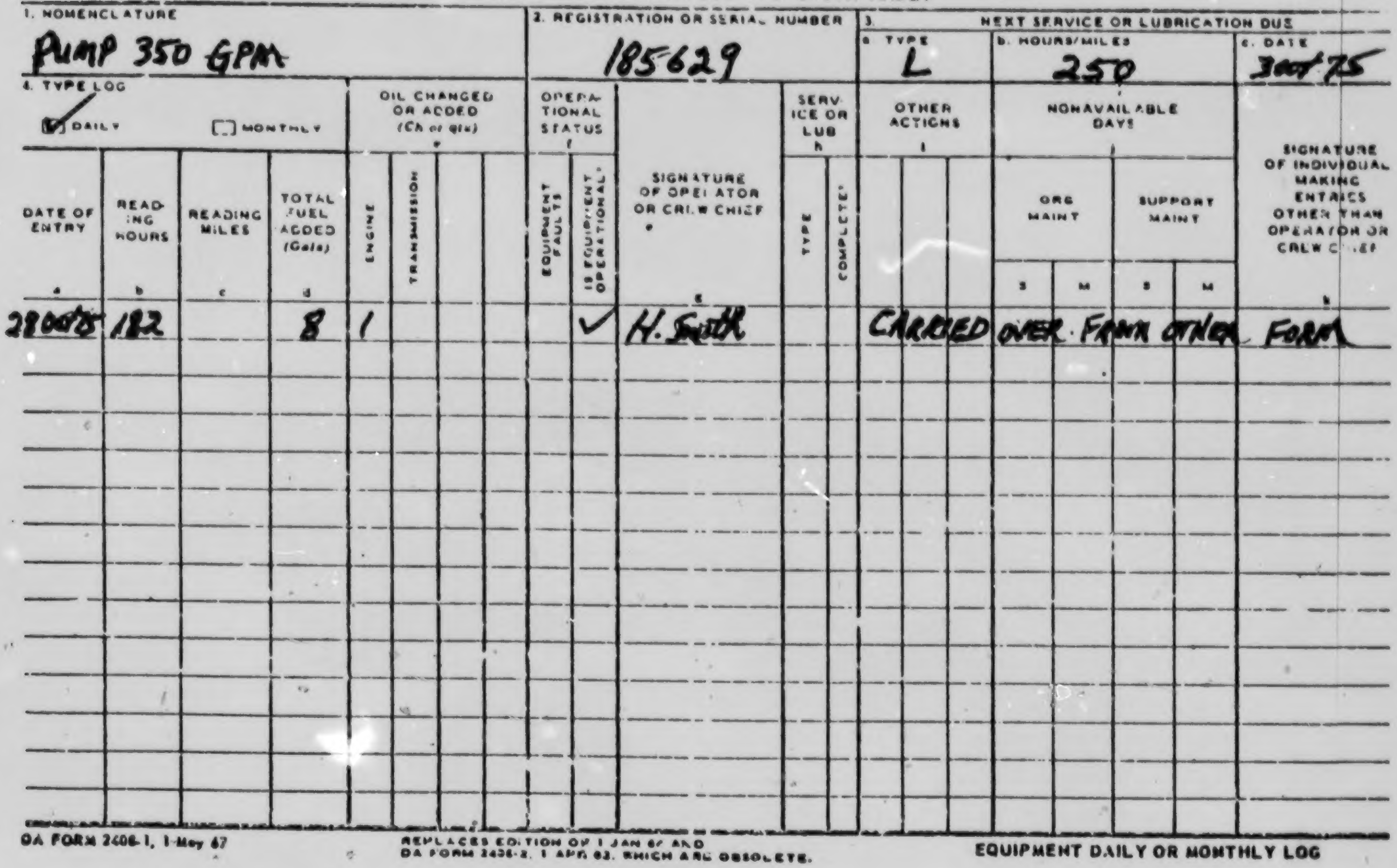
DA FORM 2408-1, 1 May 67 — REPLACES EDITION OF 1 JAN 64 AND DA FORM 2408-2, 1 APR 63, WHICH ARE OBSOLETE. — EQUIPMENT DAILY OR MONTHLY LOG

TURN THE PAGE

SITUATION

On 29 Oct 75, PFC Smith ran a pump and then prepared DA Form 2408-1. He had no problems. After operations he added 6 gallons of gas and a quart of oil. Hour meter read 185.

FILL IN THE ENTRIES PFC SMITH MADE:



1. NOMENCLATURE: PUMP 350 GPM
2. REGISTRATION OR SERIAL NUMBER: 185629
3. NEXT SERVICE OR LUBRICATION DUE: a. TYPE: L b. HOURS/MILES: 250 c. DATE: 3 Oct 75
4. TYPE LOG: ☑ DAILY ☐ MONTHLY

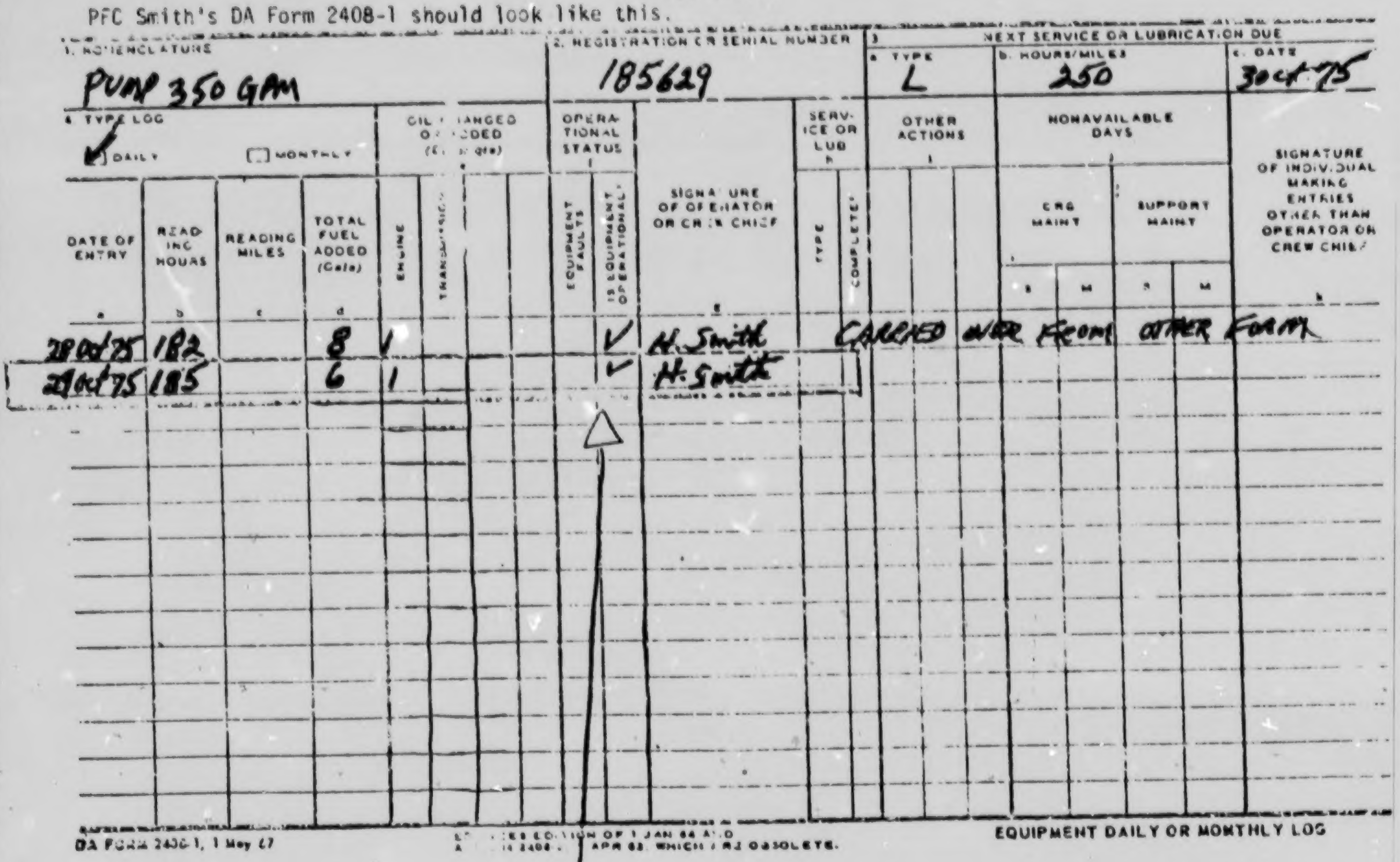
				OIL CHANGED OR ADDED (Ch or qts) e				OPERATIONAL STATUS f			SERVICE OR LUB h		OTHER ACTIONS i			NONAVAILABLE DAYS				
																ORG MAINT		SUPPORT MAINT		
DATE OF ENTRY a	READING HOURS b	READING MILES c	TOTAL FUEL ADDED (Gals) d	ENGINE	TRANSMISSION			EQUIPMENT FAULTS	IS EQUIPMENT OPERATIONAL	SIGNATURE OF OPERATOR OR CREW CHIEF g	TYPE	COMPLETE				S	M	S	M	SIGNATURE OF INDIVIDUAL MAKING ENTRIES OTHER THAN OPERATOR OR CREW CHIEF k
28 Oct 75	182		8	1					✓	H. Smith			CARRIED OVER FROM OTHER FORM							

DA FORM 2408-1, 1 May 67 REPLACES EDITION OF 1 JAN 67 AND DA FORM 2408-2, 1 APR 63, WHICH ARE OBSOLETE. EQUIPMENT DAILY OR MONTHLY LOG

GO ON FOR DISCUSSION

DISCUSSION

PFC Smith's DA Form 2408-1 should look like this.



1. NOMENCLATURE PUMP 350 GPM

2. REGISTRATION OR SERIAL NUMBER 185629

3. NEXT SERVICE OR LUBRICATION DUE

a. TYPE L

b. HOURS/MILES 250

c. DATE 30Oct75

4. TYPE LOG ☑ DAILY ☐ MONTHLY

DATE OF ENTRY	READING HOURS	READING MILES	TOTAL FUEL ADDED (Gals)	OIL CHANGED OR ADDED (Enter qts)				OPERATIONAL STATUS		SIGNATURE OF OPERATOR OR CREW CHIEF	SERVICE OR LUB		OTHER ACTIONS			NONAVAILABLE DAYS				SIGNATURE OF INDIVIDUAL MAKING ENTRIES OTHER THAN OPERATOR OR CREW CHIEF
				ENGINE	TRANSMISSION			EQUIPMENT FAULTS	IS EQUIPMENT OPERATIONAL?		TYPE	COMPLETED?				ORG MAINT		SUPPORT MAINT		
																S	M	S	M	
a	b	c	d	e				f		g	h		i			j				k
28Oct75	182		8	✓					✓	H. Smith	CARRIED OVER FROM OTHER FORM									
29Oct75	185		6	1					✓	H. Smith										

DA FORM 2408-1, 1 May 67

REPLACES EDITION OF 1 JAN 64 AND [illegible] 2408-[illegible] APR 63, WHICH ARE OBSOLETE.

EQUIPMENT DAILY OR MONTHLY LOG

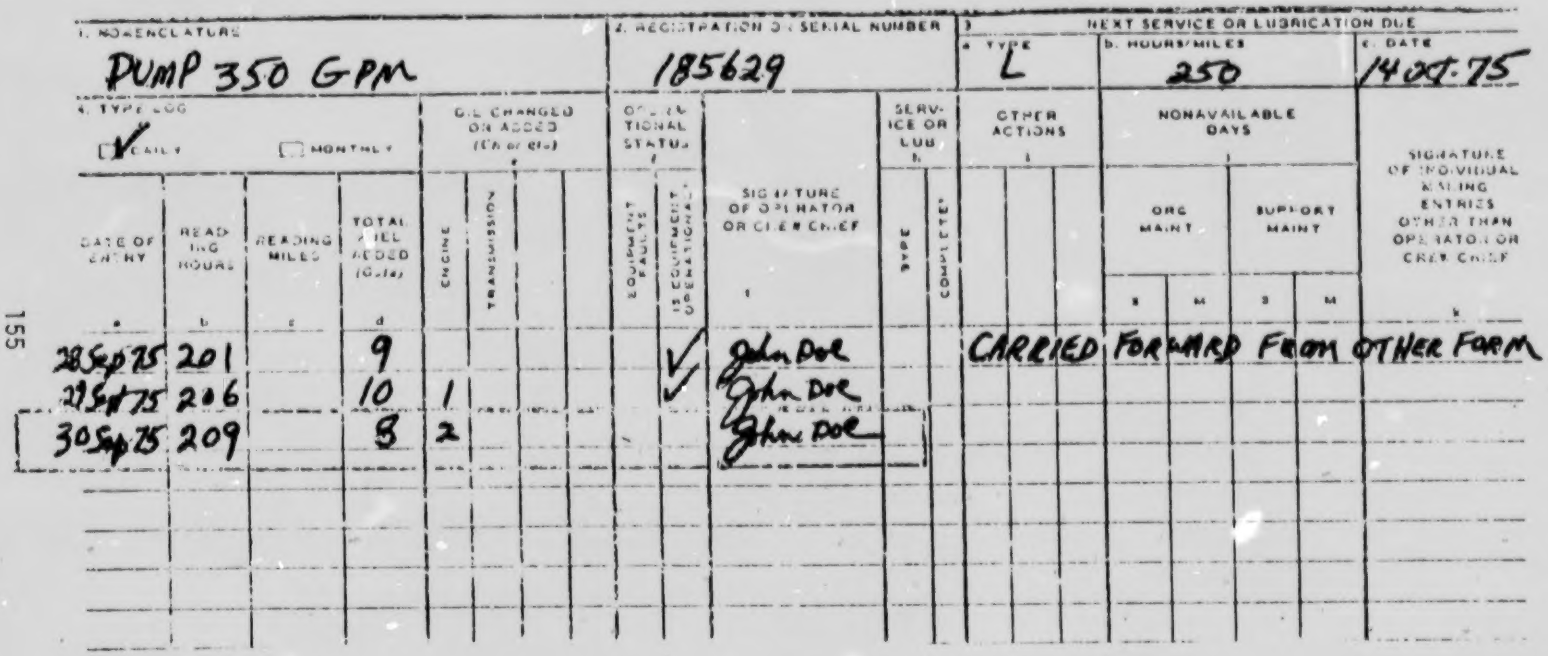
The operator fills in column a thru e.
If no problems: ✓ equipment operation

DID YOU GET IT?
REVIEW IF NECESSARY BEFORE YOU FLIP THE PAGE

EXAMPLE

The next time PFC Doe had a pump and DA Form 2408-1 the tow bar was bent during operations. A bent tow bar will limit the pump's operation. He ended operations with 300 hours on the pump. The pump took 2 quarts of oil and 8 gallons of gasoline.

THE DA FORM 2408-1 DOE PREPARED IS BELOW



1. NOMENCLATURE: PUMP 350 GPM
2. REGISTRATION OR SERIAL NUMBER: 185629
3. NEXT SERVICE OR LUBRICATION DUE: a. TYPE: L b. HOURS/MILES: 250 c. DATE: 14 Oct 75
4. TYPE LOG: ☑ DAILY ☐ MONTHLY

DATE OF ENTRY a	READING HOURS b	READING MILES c	TOTAL FUEL ADDED (Gals) d	OIL CHANGED OR ADDED (Ch or Qts) e: ENGINE	TRANSMISSION			OPERATIONAL STATUS f: EQUIPMENT FAULTS	IS EQUIPMENT OPERATIONAL	SIGNATURE OF OPERATOR OR CREW CHIEF g	SERVICE OR LUB h: TYPE	COMPLETED	OTHER ACTIONS i			NONAVAILABLE DAYS j: ORG MAINT S	ORG MAINT M	SUPPORT MAINT S	SUPPORT MAINT M	SIGNATURE OF INDIVIDUAL MAKING ENTRIES OTHER THAN OPERATOR OR CREW CHIEF k
28Sep75	201		9						✓	John Doe			CARRIED FORWARD FROM OTHER FORM							
29Sep75	206		10	1					✓	John Doe										
30Sep75	209		8	2						John Doe										

DO NOT CHECK ✓ EQUIPMENT OPERATIONAL
IF YOU ENTER A STATUS SYMBOL

GO ON TO NEXT PAGE

SITUATION

On 30 Oct 75, PFC Smith ran a pump and finished up with 189 hours on the meter. He added a quart of oil and 9 gallons of gasoline. He had some bad luck and broke the toolbox mounting. A toolbox is a nice to have item.

PREPARE DA FORM 2408-1 BELOW:

1. NOMENCLATURE PUMP 350 GPM

2. REGISTRATION OR SERIAL NUMBER 185629

3. NEXT SERVICE OR LUBRICATION DUE
a. TYPE L
b. HOURS/MILES 250
c. DATE 30 OCT 75

4. TYPE LOG ☑ DAILY ☐ MONTHLY

DATE OF ENTRY	READING HOURS	READING MILES	TOTAL FUEL ADDED (Gals)	OIL CHANGED OR ADDED (Ch or qts)				OPERATIONAL STATUS		SIGNATURE OF OPERATOR OR CREW CHIEF	SERVICE OR LUB		OTHER ACTIONS			NONAVAILABLE DAYS				SIGNATURE OF INDIVIDUAL MAKING ENTRIES OTHER THAN OPERATOR OR CREW CHIEF
				ENGINE	TRANSMISSION			EQUIPMENT FAULTS	IS EQUIPMENT OPERATIONAL?		TYPE	COMPLETED				ORG MAINT S	ORG MAINT M	SUPPORT MAINT S	SUPPORT MAINT M	
a	b	c	d	e				f		g	h		i							k
28 Oct 75	182		8	1					✓	H. Smith	CARRIED OVER FROM OTHER FORM									
29 Oct 75	135		6	1					✓	H. Smith										

DA FORM 2408-1, 1 May 67

REPLACES EDITION OF 1 JAN 64 AND DA FORM 2408-2, 1 APR 63, WHICH ARE OBSOLETE.

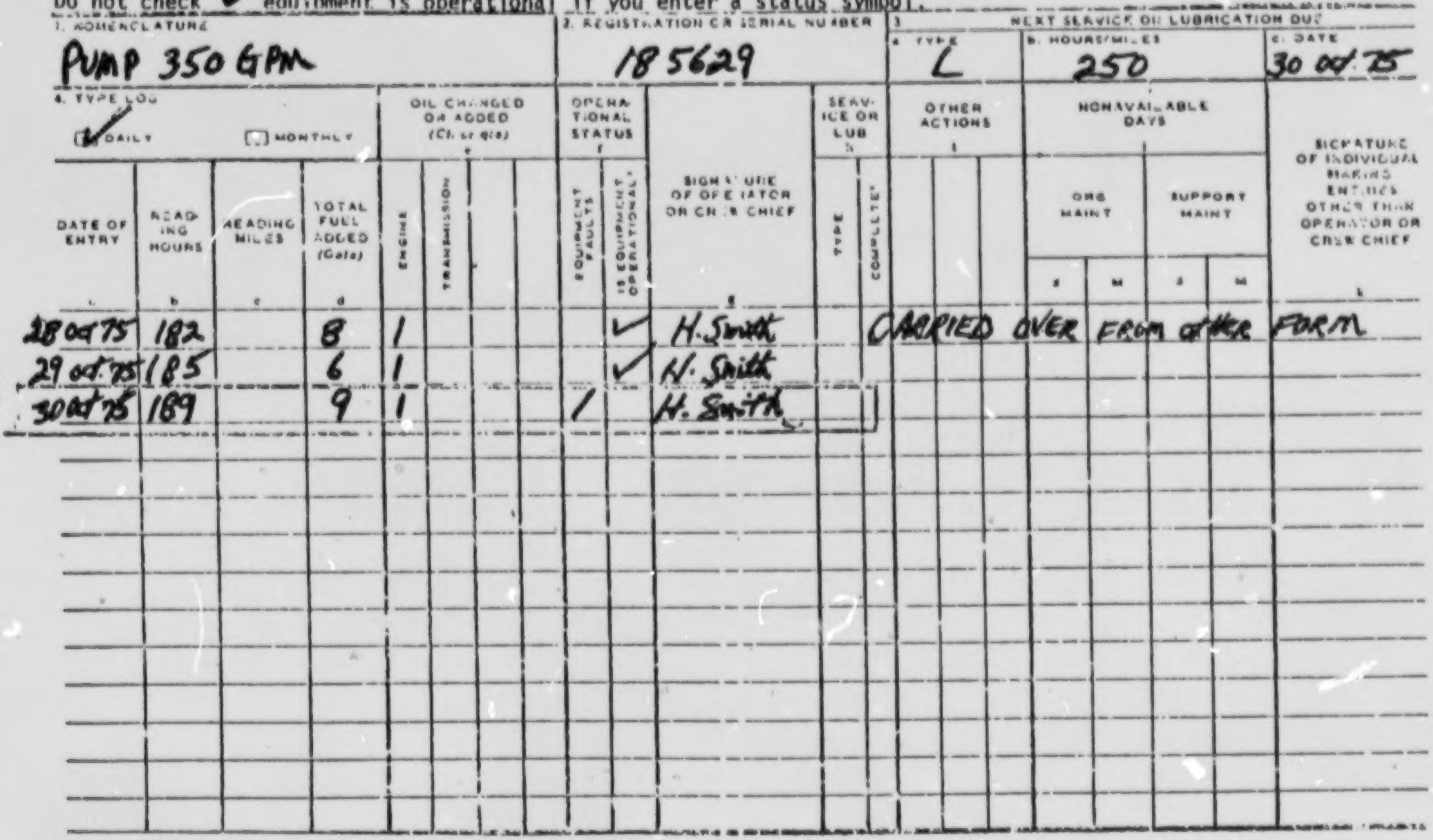
EQUIPMENT DAILY OR MONTHLY LOG

FLIP PAGE FOR DISCUSSION

DISCUSSION

/ Status symbol should be entered because a toolbox is nice to have, but not required for the pump to operate.

Do not check ✓ equipment is operational if you enter a status symbol.



1. NOMENCLATURE: PUMP 350 GPM
2. REGISTRATION OR SERIAL NUMBER: 185629
3. NEXT SERVICE OR LUBRICATION DUE: a. TYPE: L b. HOURS/MILES: 250 c. DATE: 30 oct 75
4. TYPE LOG: ☑ DAILY ☐ MONTHLY

DATE OF ENTRY a	READING HOURS b	READING MILES c	TOTAL FUEL ADDED (Gals) d	OIL CHANGED OR ADDED (Ct. or qts) e ENGINE	TRANSMISSION			OPERATIONAL STATUS f EQUIPMENT FAULTS	IS EQUIPMENT OPERATIONAL?	SIGNATURE OF OPERATOR OR CREW CHIEF g	SERVICE OR LUB h TYPE	COMPLETE?	OTHER ACTIONS i			NONAVAILABLE DAYS j ORG MAINT S	M	SUPPORT MAINT S	M	SIGNATURE OF INDIVIDUAL MAKING ENTRIES OTHER THAN OPERATOR OR CREW CHIEF k
28 oct 75	182		8	1					✓	H. Smith			CARRIED OVER FROM OTHER FORM							
29 oct 75	185		6	1					✓	H. Smith										
30 oct 75	189		9	1				/		H. Smith										

This is the end of the written program. At this point you may: (1) review the program (2) turn the page and do the review exercises.

REVIEW EXERCISES

Prepare your TAMMS Forms based on the following information:

DATE	23 Feb 75
OPERATOR	John Johnson
HOURS IN	230
TIME IN	1730
ADD OIL	None
ADD GAS	7 Gallons
PROBLEMS	Cracked reflector (TM Item No. 6)
REPAIRS	Replaced reflector

DA FORM 2408-14 - No entries for any problems.

HOW DID YOU DO?

AT THIS POINT CHECK WITH AN INSTRUCTOR
FOR A REVIEW AND YOUR EXAM

EQUIPMENT UTILIZATION RECORD

For use of this form, see TM 38 750; the proponent agency is Office of Deputy Chief of Staff for Logistics.

DATE 23 Feb 75	TYPE Pump 350 GPM	USA NUMBER SERIAL NUMBER 173575	ADMINISTRATION NUMBER PO 90

ORGANIZATION HHC, QMS	ACTION	TIME	MILES	HOURS	
1ST OPERATOR Pfc. James Smith	IN				REPORT TO Sfc. Williams
OPERATOR'S SIGNATURE	OUT	0830		224	DISPATCHER'S SIGNATURE Sp4 Springfield
	TOTAL				
2ND OPERATOR	IN				REPORT TO
OPERATOR'S SIGANTURE	OUT				DISPATCHER'S SIGNATURE
	TOTAL				
3RD OPERATOR	IN				REPORT TO
OPERATOR'S SIGNATURE	OUT				DISPATCHER'S SIGNATURE
	TOTAL				
4TH OPERATOR	IN				REPORT TO
OPERATOR'S SIGNATURE	OUT				DISPATCHER'S SIGNATURE
	TOTAL				

DESTINATION	TIME		RELEASED BY (Signature)	REMARKS
	ARRIVE	DEPART		
FROM 1.				
TO 2.				
TO 3.				
TO 4.				
TO 5.				
TO 6.				
TO 7.				
TO 8.				
TO 9.				
TO 10				
TO 11				
TO 12				
TO 13				
TO 14				
TO 15				

DA FORM 1 JAN 64 2400

EQUIPMENT INSPECTION AND MAINTENANCE WORKSHEET

(TM 38-750)

1. ORGANIZATION HHC, QMS				2. NOMENCLATURE AND MODEL PUMP 350 GPM GUH28			
3. REGISTRATION/SERIAL/FSN 173515	4a. MILES	b. HOURS	c. ROUNDS FIRED	d. HOT STARTS	5. DATE	6. TYPE INSPECTION DAILY	

7. APPLICABLE REFERENCE

TM NUMBER	TM DATE	TM NUMBER	TM DATE
10-4930-203-13	MAY 65		

INSTRUCTIONS—Perform each check listed in the TM applicable to the inspection performed. Following the sequence listed in pertinent TM, complete form as follows:

COLUMN a—Enter TM item number.

COLUMN b—Enter the applicable condition status symbol.

COLUMN c—Enter deficiencies and shortcomings.

COLUMN d—Show corrective action for deficiency or shortcoming listed in Column c.

COLUMN e—Individual ascertaining completed corrective action initial in this column.

ALL INSPECTIONS AND EQUIPMENT CONDITIONS RECORDED ON THIS FORM HAVE BEEN DETERMINED IN ACCORDANCE WITH DIAGNOSTIC PROCEDURES AND STANDARDS IN THE TM CITED HEREON.

8a. SIGNATURE (Person(s) performing inspection)	8b. TIME	9a. SIGNATURE (Maintenance Supervisor)	9b. TIME	10. MANHOURS REQUIRED

TM ITEM NO. a	STATUS b	DEFICIENCIES AND SHORTCOMINGS c	CORRECTIVE ACTION d	INITIAL WHEN CORRECTED e
		20 FEB 75		J.O.
		21 FEB 75		J.O.
		22 FEB 75		J.O.

DA FORM 1 JAN 64 2404

For use of this form, see TM 38-750; the proponent agency is Office of the Deputy Chief of Staff for Logistics.

1. NOMENCLATURE: PUMP 350 GPM

2. REGISTRATION OR SERIAL NUMBER: 173515

3. NEXT SERVICE OR LUBRICATION DUE
a. TYPE: L
b. HOURS/MILES: 250
c. DATE: 25 MAR 75

4. TYPE LOG: ☑ DAILY ☐ MONTHLY

DATE OF ENTRY a	READING HOURS b	READING MILES c	TOTAL FUEL ADDED (Gals) d	OIL CHANGED OR ADDED (Ch or qts) e ENGINE	TRANSMISSION			OPERATIONAL STATUS f EQUIPMENT FAULTS	IS EQUIPMENT OPERATIONAL?	SIGNATURE OF OPERATOR OR CREW CHIEF g	SERVICE OR LUB h TYPE	COMPLETE?	OTHER ACTIONS i			NONAVAILABLE DAYS ORG MAINT S	M	SUPPORT MAINT S	M	SIGNATURE OF INDIVIDUAL MAKING ENTRIES OTHER THAN OPERATOR OR CREW CHIEF k
22 Feb 75	224		6	1					✓	G.I.E	CARRIED OVER FROM OTHER FORM									

DA FORM 2408-1, 1 May 67

REPLACES EDITION OF 1 JAN 64 AND DA FORM 2408-2, 1 APR 63, WHICH ARE OBSOLETE.

EQUIPMENT DAILY OR MONTHLY LOG

NOMENCLATURE
350 GPM PUMP

2. MODEL
PUMP 350 GPM

3. SERIAL NUMBER
173515

STATUS SYMBOL a	FAULT b	REASON FOR DELAY c	DATE (From DA Form 2404 or 2408-13) d	ENTRY APPROVED (Signature) e	DATE (To DA Form 2408-3, 2407, or 2408-13) f

DA FORM 2408-14, 1 JAN 64 For use of this form, see TM 38-750; proponent agency is Deputy Chief of Staff for Logistics. UNCORRECTED FAULT RECORD

Army-Fort Lee, VA-5289-80-600-C

NIPUB 358(IG)C

PETROLEUM SUPPLY SPECIALIST
MOS 76W10

INSTRUCTOR GUIDE
Annex C

U.S. ARMY QUARTERMASTER SCHOOL
FORT LEE, VIRGINIA

SUPPLY TRAINING CENTER OF THE ARMY SCHOOL SYSTEM

ATSM-DT-TM-OT-ET
MAY 1978
REPRINT DATE JUNE 1979

Army Fort Lee, Va 6678-79-50-1

CONTENTS

Paragraph	Title	Page
1	Purpose	1
2	Annex Goals	1
3	Instructional Organization and Responsibility	1
4	Student Morale and Control	1
5	Individualized Instruction	1
6	Control and Distribution of Materials	2
7	Pretesting	2
8	Student Records	2
9	Contents of Annex C, Class III Supply Point Operations	2
10	Conducting Instruction on Block C-1: Introduction to Supply Point Operations	2
11	Conducting Instruction on Block C-2: Operation of the 50 GPM Pump, 500-Gallon Collapsible Drum, and Filling Cans and Drums	4
12	Conducting Instruction on Block C-3: Operation of the FARE System	5
13	Conducting Instruction on Block C-4: Operation of Tank and Pump Unit	6
14	Conducting Instruction on Block C-5: Rigging for External Helicopter Airlift	8
15	Conducting Instruction on Block C-6: Operation of the 350-GPM Pump and Filter/Separator	8
16	Conducting Instruction on Block C-7: Position, Layout, and Operation of the Fuel System Supply Point (FSSP)	9
17	Conducting Instruction on Block C-8: Tank Vehicle Operations	11
APPENDIX A	Course Map	14
APPENDIX B	Instructor Control Record	15
APPENDIX C	References	16

INSTRUCTOR GUIDE

76W, Petroleum Supply Specialist

Annex C, Class III Supply Point Operations

1. PURPOSE. This guide provides you, the instructor, with directions to conduct this course. This guide is not a technical manual of subject matter covered in this annex. When questions arise for which you cannot find the answers in this guide, use the references listed with each block of instruction.

2. ANNEX GOALS. The goals of this annex are to teach enlisted personnel the job skills pertaining to the operation and maintenance of the 50 gallon per minute (GPM) pump unit, the 350 GPM pump and filter/separator system, and the 1200-gallon tank vehicle. Students will be taught how to set up and operate a forward area refueling equipment (FARE) system and the layout and identification system used to operate and maintain a fuel system supply point. The basic skills in tank vehicle and aircraft refueling operations are also taught in this annex.

3. INSTRUCTIONAL ORGANIZATION AND RESPONSIBILITY. If you have a sufficient number of qualified personnel, a team of instructors should be formed. The team chief is the senior instructor responsible for the overall conduct of instruction. This arrangement eases the job of training and lends itself to individualized instruction.

4. STUDENT MORALE AND CONTROL. As an instructor, you should be alert to signs of student difficulties and make every effort to solve problems. Students who progress rapidly should be allowed to go on to the next lesson, or be assigned as a student aid to help other students with learning difficulties. Students who are slow but conscientious workers must be encouraged to continue studying. Never ridicule a student. Give praise and commendation for progress whenever merited. Students who refuse to apply themselves or do not pay attention should be counseled. Students who continue to have problems not directly related to learning difficulties (i.e., inability to read or comprehend) should be referred to command.

5. INDIVIDUALIZED INSTRUCTION. Individualized instruction is tailored to the needs of the student. The instructor should circulate among the students to answer questions and insure they will finish in the prescribed time. Text materials are written at the 7th to 9th grade reading level. This will be well within the grasp of most students. However, instructors should be alert for students with reading comprehension problems.

6. CONTROL AND DISTRIBUTION OF MATERIALS. This is a self-paced course. Students should be free to progress through the annex at their own speed. Before beginning a block of instruction, you should provide your students with all references, handouts, and programed texts (PT's). When the student has completed the reading assignment and indicates that he/she is ready, administer the checklist examination. Students are expected to achieve a score of at least 70% in two attempts. A pretest counts as one attempt. Students should not be allowed to go on to a block of instruction until they have successfully completed all preceeding blocks. Remember, all programed texts are self-teaching materials which contain step-by-step explanation and demonstration, review, and self-grading performance requirements. Because each instructional block includes a complete processing procedure, each block must be completed in the sequence shown on the course map (appendix A).

7. PRETESTING. If a student indicates he/she knows the material before studying the instruction, you may pretest the student. Give the individual a copy of the pretest examination to review. If the student is able to achieve 70% on the checklist examination, allow him/her to proceed to the next block of instruction. If the student does not achieve the required 70% have him/her study the material and prepare for a retest.

8. STUDENT RECORDS. Student folders and control cards must be prepared for each student enrolled in the course. These records should reflect the student's progress, time expended on each block of instruction and examination scores. Copies of records, counseling and other pertinent remarks you consider vital should be attached to the student control card. When a student completes an annex you should give these records to the student's next instructor. A sample format is attached at Appendix B.

9. CONTENTS OF ANNEX C, CLASS III SUPPLY POINT OPERATIONS. This annex contains nine blocks of instruction, which must be completed by the student in numerical sequence with the exception of instruction block C-5, which is in the process of being transferred to the Airborne Department as proponent for training development materials. After the students have successfully completed this annex, they will have learned basic principles of operation and maintenance of petroleum distribution and dispensing equipment used at a class III supply point in a theater of operations.

10. CONDUCTING INSTRUCTION ON BLOCK C-1: INTRODUCTION TO SUPPLY POINT OPERATIONS. This block of instruction defines terms and maintenance practices used by personnel who work at a class III supply point.

a. Objective.

(1) Condition. The student is given an equipment checklist and procedures for conducting operator maintenance before, during, and after the equipment is used.

(2) Action. The student will be able to--

(a) check engine oil and gasoline levels of specified equipment before, during, and after operational use.

(b) check engine radiators of specified equipment for sufficient water or coolant before operational use.

(c) check the battery of specified equipment for the acid level and corrosion. Clean battery parts, if necessary.

(d) remove and check nozzle strainers on fuel dispensing equipment. Clean the strainers, if necessary.

(e) clean air filters, dust caps, spark plugs, and sediment bowls on specified equipment. Replace item if necessary.

(f) list nine safety measures that should be followed by persons who work at or near petroleum storage and dispensing facilities.

(3) Standard. The student must perform or answer correctly at least 70 percent of performance tasks or written requirements specified on the checklist examination.

b. Logistical Requirements.

(1) Materials. Pen, pencil, Student Guide.

(2) References. TM 10-1101, Petroleum Handling Equipment and Operations.

(3) Setting. Classroom, petroleum training facility.

(4) Allotted Time. 1 hour. (NOTE: The allotted time indicated for each block is not a fixed time limit. It is a suggested time frame based on past experiences that the average student needs to complete the instruction block. Since this is a self-paced course of instruction, the instructor is free to increase or decrease the allotted time to each student's particular need or capability.)

(5) Equipment. Assorted vehicular and petroleum generating equipment, engine oil, gasoline.

c. Directions for Carrying Out Instruction. Assure the steps below are followed during the instruction process.

(1) Step 1. Students should read and study QMS 300.719 H1 and material in TM 10-1101 pertaining to operational maintenance and safety practices at a class III supply point.

229

(2) Step 2. Have student perform tasks required in Actions a-f above.

(3) Step 3. When you are satisfied that the students have satisfactorily completed the requirements of this instruction block, let them proceed to instruction block C-2.

11. CONDUCTING INSTRUCTION ON BLOCK C-2: OPERATION OF THE 50 GPM PUMP, 500 GALLON COLLAPSIBLE DRUM, AND FILLING CANS AND DRUMS. During this block of instruction the students will learn the names and functions of engine components for a 50 gallon pump assembly. Operational procedures are discussed, including safety checks; grounding a pump; preoperational maintenance; assembly layout; and starting, pumping, and shutdown procedures.

a. Objective.

(1) Condition. The student is given a 50 gpm (gallons per minute) pump assembly, 5-gallon can, 55-gallon drum, and 500-gallon collapsible drum and operational and maintenance procedures for using the unit.

(2) Action. The student will be able to--

(a) identify by name and function the engine controls and components of a 50-gpm pump assembly.

(b) perform a preoperational maintenance and safety checks on a 50-gpm petroleum pump unit to include completion of DA Form 2404 (Equipment Inspection and Maintenance Worksheet).

(c) start, operate, and stop a 50-gpm pump unit according to pumping procedures described in TM 10-1101.

(d) fill and defuel 5-gallon can, 55-gallon drum, and 500-gallon collapsible drum, using a 50-gpm pump.

(3) Standard. The student must perform or answer correctly at least 70 percent of performance tasks or written requirements specified on checklist examination.

b. Logistical Requirements.

(1) Materials. Paper, pencil, Student Guide, and gasoline.

(2) References. TM 10-1101, Petroleum Handling Equipment and Operation; TM 10-4320-202-15, Operator, Organizational, Direct Support and General Support Maintenance Manual; Pumping Assembly, 50 GPM.

(3) Setting. Classroom, petroleum training facility.

(4) Allotted Time. 14 hours. (See paragraph 10b(4) for adjustment of time allotment.)

(5) Equipment. 50 GPM pump assembly, 5-gallon can, 50-gallon drum, 500-gallon collapsible drum.

c. Directions for Carrying Out Instruction. Make sure the steps below are followed during the instruction process.

(1) Step 1. Students should read and study material in TM 10-1101 and 10-4320-202-15 pertaining to operation of the 50 GPM pumping assembly.

(2) Step 2. Students should report to the petroleum training facility (PTF) where they will be given programed text QMS 300.432 PT and other pertinent materials used to perform the tasks outlined in this instruction block.

(3) Step 3. Students should complete Part I of QMS 300.432 PT.

(4) Step 4. Students should complete Part II of QMS 300.432 PT.

(5) Step 5. Students will take a checklist examination based on the material covered in the programed text.

(6) Step 6. When you are satisfied that the students have satisfactorily completed all requirements of this instruction block, let them proceed to instruction block C-3.

12. CONDUCTING INSTRUCTION ON BLOCK C-3: OPERATION OF THE FARE SYSTEM. During this block of instruction the students will learn the forward area refueling equipment (FARE) used to refuel helicopters during combat operations. This system is set up in isolated or special areas in which conventional refueling stations cannot operate.

a. Objective.

(1) Condition. The student is placed in a PTF equipped with a 100-GPM pump and hose assembly and forward area refueling equipment and accessories.

(2) Action. The student will be able to--

(a) set up a FARE system, including positioning of drums and proper hookup of couplings, fittings, grounding rod, and other components.

(b) perform maintenance checks before, during, and after operating pump and related hose assembly.

(c) operate a two-point FARE system for refueling aircraft.

(3) Standard. The student must perform or answer correctly at least 70 percent of the performance tasks or written requirements specified on the checklist examination.

b. Logistical Requirements.

(1) Materials. Pen, pencil, petroleum products.

(2) References. TM 5-4320-248-15, Operator, Organizational, Direct and General Support, and Depot Maintenance Manual: Pump; 100 GPM, Portable Refueling System; QMS 300.664 PT, Forward Area Refueling Equipment (FARE) System.

(3) Setting. Classroom, petroleum training facility.

(4) Allotted Time. 4 hours. (See paragraph 10b(4) for adjustment of time allotment.)

(5) Equipment. 100 GPM pump assembly, 500-gallon collapsible drums, 5-foot suction hose.

c. Directions for Carrying Out Instruction. Make sure the steps below are followed during the instruction process:

(1) Step 1. Students should read and study appropriate material in TM 5-4320-248-15 pertaining to the use and operation of a FARE system.

(2) Step 2. Have students read and practice the lesson assignment in QMS 300.664 PT.

(3) Step 3. Have the students do the practice exercise after Lesson 1 in QMS 300.664 PT.

(4) Step 4. When you feel that the students can perform operator maintenance and operate the FARE system to your satisfaction, let them take the checklist examination for this block.

(5) Step 5. If the students pass the examination with a score of 70 or higher, let them proceed to instruction block C-4.

13. CONDUCTING INSTRUCTION ON BLOCK C-4: OPERATION OF TANK AND PUMP UNIT. During this block of instruction the student will learn the major components and operation of a tank and pump unit. The method of mounting the tank and pump on a 5- or 2 1/2-ton truck are illustrated as well as the engine and filter separator system.

a. Objective.

(1) Condition. The student is placed in a PTF equipped with two 600-gallon tanks, pump assembly, a 5- or 2 1/2-ton cargo truck, 55-gallon drum, and 500-gallon collapsible drum.

(2) Action. The student will be able to--

(a) install a tank and pump unit on a 5- or 2 1/2-ton cargo truck.

(b) identify the major components of a tank and pump assembly.

(c) perform operator maintenance checks before, during, and after operation of equipment.

(d) operate tank and pump unit to fill and defuel a 55-gallon drum and 500-gallon collapsible drum.

(3) Standard. The student must perform or answer correctly at least 70 percent of performance tasks or written requirements specified on the checklist examination.

b. Logistical Requirements.

(1) Materials. Paper, pencil, Student Guide, petroleum products.

(2) References. TM 10-4930-204-15, Operator's, Organizational, Direct Support, General Support, and Depot Maintenance Manual: Tank and Pump Unit, Liquid Dispensing; for Truck Mounting; QMS 300.596-1 H-1, Tank and Pump Unit.

(3) Setting. Classroom, petroleum training facility.

(4) Allotted Time. 8 hours. (See paragraph 10b(4) for adjustment of time allotment.)

(5) Equipment. Tank and Pump Unit, 55-gallon drum, 500-gallon collapsible drum, two 600-gallon tanks, one 5- or 2 1/2-ton truck.

c. Directions for Carrying Out Instruction. Make sure the steps below are followed out during the instruction process:

(1) Step 1. Students should read and study the appropriate material in TM 10-4930-204-15 pertaining to the operation of the tank and pump unit for dispensing liquid products.

(2) Step 2. Have students read each part of QMS 300.596-1 H-1 and perform the five operations required in this instructional block.

(3) Step 3. When you are satisfied that the students have satisfactorily completed the requirements of this instruction block, administer the checklist examination to each student individually.

(4) Step 4. If the students achieve a passing score of 70 or higher on the performance exaination, let them proceed to instruction block C-5.

14. CONDUCTING INSTRUCTION BLOCK C-5: RIGGING FOR EXTERNAL HELICOPTER AIRLIFT. There are no self-paced materials for this instructional block available for exportable purposes at the present time. It is contemplated that proponency for these materials will be transferred from petroleum and field services to the airborne department in the near future. Have the students proceed to instruction block C-6.

15. CONDUCTING INSTRUCTION ON BLOCK C-6: OPERATION OF THE 350-GPM PUMP AND FILTER/SEPARATOR. During this block of instruction, the student will learn the operation of the 350 GPM pump and filter/separator. This assembly has a portable capability and is used by the Army where a relatively high rate of pumping action is required quickly for short periods of time.

a. Objective.

(1) Condition. The student is placed in a petroleum training facility equipped with a 350 GPM pump, 350 GPM filter/separator, collapsible storage tanks, and problem situations pertaining to adjustments and operations of the equipment.

(2) Action. The student will be able to--

(a) identify the major components of a 350 GPM pump assembly.

(b) perform operator maintenance and safety checks on a 350 GPM pump assembly.

(c) operate the 350 GPM pump, including starting and stopping the unit.

(d) identify the major components of a 350 GPM filter/separator.

(e) perform operator safety and maintenance checks on the 350 GPM filter/separator.

(f) operate the 350 GPM filter/separator to include checking and recording pressure readings.

(3) Standard. The student must perform or answer correctly at least 70 percent of performance tasks or written requirements specified on the checklist examination.

b. Logistical Requirements.

(1) Materials. Paper, pencil, Student Guide, petroleum products.

(2) References. TM 5-4320-200-15, Operator's, Organizational, Direct Support, General Support, and Depot Maintenance Manual: Pump, Centrifugal; TM 5-4320-218-15, Operator's, Organizational, Direct Support, General Support, and Depot Maintenance Manual: Pump, Centrifugal, Petroleum; 350 GPM.

(3) Setting. Classroom, petroleum training facility.

(4) Allotted Time. 10 hours. (See paragraph 10b(4) for adjustment of time allotment.)

(5) Equipment. 350 GPM pump, 350-GPM filter/separator, collapsible storage tanks.

c. Directions for Carrying Out Instruction. Make sure the steps below are followed during the instruction process:

(1) Step 1. Students should read and study appropriate material in TM's 5-4320-200-15 and 5-4320-218-15 pertaining to the 350 GPM pump and filter/separator.

(2) Step 2. Have students read and practice the exercises in QMS 300.663 H-1.

(3) Step 3. Administer the checklist examination as soon as the students feel they have mastered all the steps in the operation and maintenance of the 350 GPM pump and filter/separator.

(4) Step 4. When the students have achieved the minimum passing score required on the performance examination, let them proceed to instruction block C-7.

16. CONDUCTING INSTRUCTION ON BLOCK C-7: POSITION, LAYOUT, AND OPERATION OF THE FUEL SYSTEM SUPPLY POINT (FSSP). During this block of instruction the students will cover the identification and layout of all component parts of a fuel system supply point (FSSP), including the operations and maintenance of the system.

a. Objective.

(1) Condition. The student is placed in a petroleum training facility and provided a diagram showing the layout of all component parts of a fuel system supply point, to include six 10,000-gallon collapsible storage tanks.

(2) Action. The student will be able to--

(a) identify all component elements of an FSSP.

(b) set up without error one half of an FSSP that is capable of storing 30,000 gallons of fuel, receiving fuel from M131 tankers at two points, unloading M131 and M49 tankers from separate points, dispensing fuel from one-inch nozzles from three separate points, transferring fuel from tank to tank within the system, and receiving and issuing fuel at the same time.

(3) Standard. A 6-10-student group must construct one half of a FSSP correctly without the use of diagrams on text material within the time frame specified for the group.

b. Logistical Requirements.

(1) Materials. Paper, pencil, Student Guide.

(2) References. TM 10-4930-203-13, Operator, Organizational and Direct Support Maintenance Manual: Fuel System Supply Point; TM 10-1101, Petroleum Handling Equipment and Operation.

(3) Setting. Classroom, petroleum training facility.

(4) Allotted Time. 20 hours. (See paragraph 10b(4) for adjustment of time allotment.)

(5) Equipment. Six 10,000 gallon collapsible storage tanks, all component parts of a fuel system supply point.

c. Directions for Carrying Out Instruction. Make sure the steps below are followed during the instruction process:

(1) Step 1. The students should read and study QMS 300.666 H-1 covering the FSSP layout and the operation of the FSSP. Have the students use TM 10-4930-203-13 as a reference source.

(2) Step 2. Have students follow the steps and directions outlined in the handout on the FSSP layout as they walk through the system.

(3) Step 3. Assign 6 to 8 students to a group and let them practice construction of the FSSP.

(4) Step 4. Have students follow the steps and directions given in the handout on operations of the FSSP. Let them practice as they study operations requirements.

(5) Step 5. Assign three or more students to the practical exercise covering the operation of the FSSP.

(6) Step 6. After students have had sufficient time to practice steps 3 and 5, have each assigned group complete the performance examination.

(7) Step 7. When you are satisfied that each group has constructed the FSSP correctly, let them proceed to instruction block C-8.

17. CONDUCTING INSTRUCTION BLOCK C-8: TANK VEHICLE OPERATIONS. During this block of instruction students will learn operation and maintenance of the M49A2C and M131A5C tank vehicles. These tank vehicles are used by the Army to fuel and defuel petroleum containers and aircraft.

a. Objective.

(1) Condition. The student is placed in a petroleum training facility and provided with tank vehicles M49A2C and M131A5C.

(2) Action. The student will be able to--

(a) perform operator maintenance on specified components of the M49A2C and M131A5C vehicle before, during, and after operations and record any necessary action on DA Form 2404 (Equipment Inspection and Maintenance Worksheet).

(b) Operate the auxiliary pumps and record pressure differential in daily log book.

(c) Fill and defuel petroleum containers and aircraft from the M49A2C tank vehicle.

(3) Standard. The student must perform or answer correctly at least 70 percent of performance tasks or written requirements specified on the checklist examination.

b. Logistical Requirements.

(1) Materials. Paper, pencil, Student Guide, DA Form 2404, Daily Log Sheets, Micronic filter differential pressure and servicing equipment.

(2) References. TM 10-1113 Petroleum Tank Vehicle Operations.

(3) Setting. Classroom, petroleum training facility.

(4) Allotted Time. 20 hours. (See paragraph 10b(4) for adjustment of time allotment.)

(5) Equipment. M49A2C and M131A4C tank vehicles.

c. Directions for Carrying Out Instruction. Make sure the steps below are followed during the instruction process.

(1) Step 1. Students should read and study the appropriate material in TM 10-1113 pertaining to the use and operation of tank vehicles.

(2) Step 2. Have students read and study QMS 300.439 H-1 (Parts I and II) and practice maintenance checks and refueling procedures on the M49A2C and M131A5C tank vehicles.

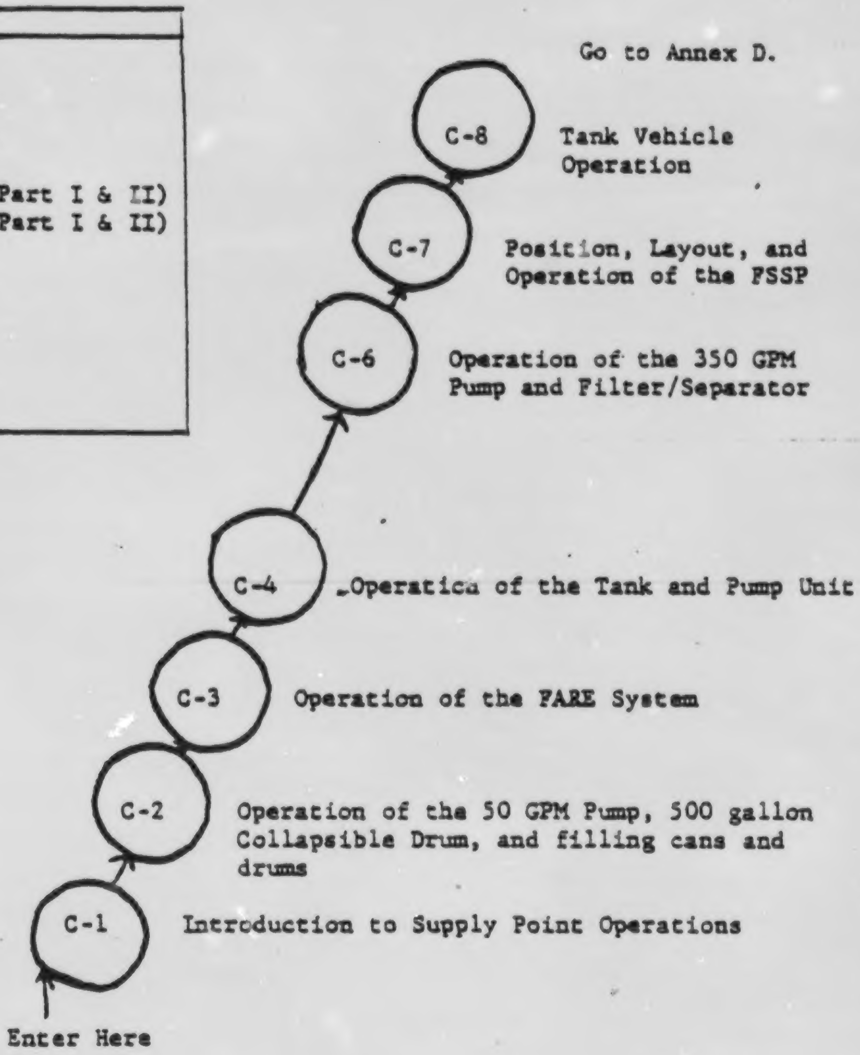
(3) Step 3. Have the students take the checklist examination if you feel they can refuel aircraft, fill and defuel containers, and perform operator maintenance on the M49A2C and M131A5C tank vehicles to your satisfaction.

(4) Step 4. If the students pass the checklist examination with a score of 70 or higher, let them proceed to Annex D.

APPENDIX A

Course Map - Annex C

ANNEX MATERIAL
QMS 300.719H-1
300.432 PT
300.664 PT
300.596-1 H-1
300.663 H-1
300.666 H-1 (Part I & II)
300.439 H-1 (Part I & II)
PSS-C-2-PEE
PSS-C-4 PFS
PSS-C-6 PFS
PSS-C-7 PFS
PSS-C-8 PFS
PSS-C-9 PFS


Go to Annex D.
C-8
Tank Vehicle Operation
C-7
Position, Layout, and Operation of the FSSP
C-6
Operation of the 350 GPM Pump and Filter/Separator
C-4
Operation of the Tank and Pump Unit
C-3
Operation of the FARE System
C-2
Operation of the 50 GPM Pump, 500 gallon Collapsible Drum, and filling cans and drums
C-1
Introduction to Supply Point Operations
Enter Here

APPENDIX B

Instructor Control Record

Student's Name______________________ Starting Date________________

BLOCK	ACTION	SUCCESSFULLY COMPLETED	REMARKS
C-1	QMS 300.719 H1		
C-2	QMS 300.432 PT		
C-3	QMS 300.664 PT Checklist Exam		
C-4	QMS 300.596-1 H1 Checklist Exam		
C-5	Optional Block		
C-6	QMS 300.663 H-1 Checklist Exam		
C-7	QMS 300.666 H-1 FSSP Layout		
C-8	QMS 300.439 H-1 Checklist Exam		

APPENDIX C

REFERENCES - ANNEX C

FM 21-41	Feb 67	Soldiers Handbook for Defense Against Chemical and Biological Operations and Nuclear Warfare
FM 21-48	Jun 73	Planning and Conducting Chemical, Biological, Radiological (CBR) and Nuclear Defense Training
TM 5-4320-200-15	Nov 68	Operator, Organizational, Direct Support, General Support and Depot Maintenance of Centrifugal Pump
TM 5-4320-218-15	Mar 61	Operator, Organizational, Direct Support, General Support, and Depot Maintenance Manual, 350 GPM Pump
TM 9-2330-274-14	Jun 72	Operator, Organizational, Direct Support and General Support Maintenance Manual for Semitrailer Tank 5000 gal M131A4C, M131A5C
TM 10-500	Jan 72	Airdrop of Supplies and Equipment: General Information for Rigging Airdrop Platforms
TM 10-1113	Jun 69	Petroleum Tank Vehicle Operation
TM 10-4320-202-15	May 68	Operator, Organizational, Direct Support and General Support Maintenance Manual 50 GPM Pump
TM 10-4930-203-13	May 65	Operator, Organizational and Direct Support Maintenance Manual Fuel System Supply Point
TM 10-4930-204-15	Sep 67	Operator, Organizational, Direct Support, General Support and Depot Maintenance Manual - Tank and Pump Unit
TM 5-4320-248-15	Oct 67	Operator, Organizational, Direct and General Support, Depot Maintenance Manual, 100 GPM Pump

NIPUB 358(SG)C

PETROLEUM SUPPLY SPECIALIST
MOS 76W10

STUDENT GUIDE
ANNEX C

U.S. ARMY QUARTERMASTER SCHOOL
FORT LEE, VIRGINIA

SUPPLY TRAINING CENTER OF THE ARMY SCHOOL SYSTEM

ATSM-TNG-TM-ET

MAY 1978

Army-Fort Lee, Va. -9125-78-850-C

242

QMS 300.719 H1

INTRODUCTION
FOR
"C" ANNEX

PROPONENT DEPARTMENT: Petroleum & Field Services

November 1976

This handout is actually a combination glossary of terms and a list of need to know information. As you go into "C" Annex and throughout the rest of this course you will be working with fuel and equipment. These definitions and rules should be remembered and used in every case where they apply. Read this handout carefully and do as directed.

1. BONDING: This term means to apply a static bond wire between two or more pieces of equipment. To be effective both ends of the bond wire should be firmly attached to bare metal.

2. GROUNDING: Grounding means to apply a static bond wire between a piece of equipment and a metal rod driven into the ground. To be effective, the wire should be firmly attached to bare metal.

3. FIRE EXTINGUISHER: In every operation you will be required to "Set out the fire extinguishers." DO NOT MOVE ANY FIRE EXTINGUISHERS. Fire extinguishers are strategically placed throughout the PTF. Your requirement as to fire extinguishers is to know at all times where the nearest fire extinguisher is located.

NOTE: You will be required to check certain items on various pieces of equipment in before, during and after operations maintenance. Following are some of these checks and how you are expected to make them.

4. CHECK THE OIL: This means to physically inspect the dip stick or remove the inspection plug to insure the crankcase has oil to the recommended level. Running an engine that is low on oil could quickly cause serious damage.

5. CHECK THE GAS: Normally gas tanks should be kept at 3/4 full. This allows for expansion of the fuel and also reduces accumulation of moisture due to condensation.

6. CHECK THE RADIATOR: Some engines are water cooled. Make sure that anti-freeze is added before cold weather begins. Before operating the engine be sure the coolant level is at the proper level. NEVER REMOVE THE CAP WHILE THE ENGINE IS RUNNING OR IMMEDIATELY AFTER SHUTTING IT OFF. These radiators are under high pressure when operating and while hot. If you should open the cap when the engine is running, you could get burned. After operations, allow the radiator to cool down before checking it. Should you be pressed for time and it becomes necessary to check

the radiator while it is still hot, place a heavy rag over the cap, several layers thick. Remove the cap slowly and let the pressure escape before taking the cap completely off. CAUTION: Do not use this technique unless it is absolutely necessary.

7. CHECK THE BATTERY: Most engines have batteries. When checking the battery remove the caps and insure the acid level is even with the fill marks inside. If they are low, add water. CAUTION: DO NOT OVERFILL. Check the cables to insure a tight fit on the posts and that they are not frayed. Remove any corrosion build up with a soft wire brush then rinse with water and dry thoroughly with a clean dry rag. BE EXTRA CAREFUL THAT THE HOT WIRE DOES NOT GET SHORTED TO GROUND. You could get seriously burned if you forget this.

8. CHECK NOZZLE STRAINER: All nozzles used for dispensing fuel are equipped with a screen. To check it, unscrew the dispensing tube and remove the screen. Tap the base gently to remove any sand or dirt then replace the screen.

9. CHECK THE AIR FILTER: There are two basic types of carburetor air filters.

a. Oil type: To check the oil type remove the pan and run your finger around the bottom to check for dirt or sand. Make sure the oil is full to the FILL line marked on the pan. If the oil is dirty, pour it in a slop can, wash the pan in solvent and put in fresh oil.

b. Cartridge type: The cartridge type filters are equipped with a vacuum actuated indicator. If while the engine is operating the indicator shows RED, press the reset button. If it shows RED again, stop the engine. Remove the cartridge and with an air gun, blow air backwards thru the filter. This should clean it. If after cleaning and replacing the filter in the engine, the indicator shows RED again, then replace the filter with a new one.

10. DUST CAPS AND PLUGS: All quick couple hoses and fittings are equipped with dust plugs and caps. Never lay these in the dirt when removing them. They are to be used to keep dust and dirt out of the hoses and fittings and special effort should be used to keep them clean at all times.

11. SEDIMENT BOWLS: Almost all engines have a glass sediment bowl in the gas line between the gas tank and carburetor. This should be visually checked daily for water or dirt. If dirt and water are found,

make sure the gas is turned off before removing the bowl and cleaning it with a soft lint-free rag. The bowl support should only be finger tight. The needle valve should be opened and closed gently with your fingers. They are easily broken if turned too tight.

12. SPILLS: Occasionally there may occur a small spill of fuel. If this happens, cease operations and clean it up immediately. Use rags to wipe off equipment and spread fresh sand over the spills on the ground. For any spill over two gallons, notify an instructor immediately for instructions. In almost every case where spills occur, it is because someone used a sloppy technique or didn't follow instructions. Use of drip pans and common sense will eliminate 99% of all spills.

13. CLEAN UP: You are responsible for leaving any area you use in clean and orderly fashion.

14. FILMS: There are TV films for almost every block of instruction. Always check with the control desk each time you get a new block of instruction and see any films applicable to that block.

SAFETY

The following are some general safety practices which should be adhered to at all times.

1. SMOKING: Smoking can be hazardous to your health. Nowhere is this more true than when working with petroleum products. A spark or flame could ignite a devastating explosion and/or a big fire instantly. DO NOT SMOKE OR ALLOW ANYONE ELSE TO SMOKE ANYWHERE IN THE PTF EXCEPT THOSE AREAS CLEARLY MARKED "SMOKING AREA."

2. HAZARDOUS NOISE AREA: Some areas in the PTF are clearly marked as "Hazardous Noise Area." Wear your protective ear plugs anytime you are in these areas.

3. HARD HAT AREA: Some areas in the PTF are marked "Hard Hat Area." If you are going to work in any of these areas, go to the supply room and sign for a protective helmet and wear it at all times in the designated areas. Turn in the helmet before leaving the PTF.

4. HORSE-PLAY: Horse-play of any kind is expressly forbidden at all times.

5. RUNNING: Running in the PTF is forbidden at all times except in extreme emergency.

6. FOOD AND DRINK: Food and drink are to be consumed in the authorized break areas only. If you have been working with fuel be sure to wash your hands before drinking or eating. Small amounts of fuel taken internally could cause diarrhea. Be sure to put waste in the proper receptacles.

7. SLEEPING: Sleeping is not permitted in any area of the PTF or classroom at any time.

8. ACCIDENTS: In any case of accident to yourself or someone else to include getting fuel on yourself, NOTIFY AN INSTRUCTOR IMMEDIATELY.

9. BUDDY SYSTEM: Never work on a piece of equipment by yourself. Always check with an instructor before starting any engine and before entering or leaving a training area.

QMS 300.432 PT

U. S. ARMY QUARTERMASTER SCHOOL

PROGRAMED TEXT

OPERATION OF 50 GPM PUMP

PROPONENT DEPARTMENT: Petroleum and Field Services

MAY 1976

INTRODUCTION:

One of the most popular and most used petroleum pumps in the Army is the 50 gallon per minutes (GPM) pump. It is light weight, portable and very dependable. This pump is the first of many types and models of pumps you will work with and learn about in this course so learn it well!

OBJECTIVE:

The student will be able to:

1. Perform operator's maintenance on the 50 GPM pump.
2. Set up and operate the pump to fill 5 gallon cans and 55 and 500 gallon drums and vehicles.

INSTRUCTION TO STUDENTS:

Read this lesson carefully and follow all the instructions given. If at any time there is something you want to look at or study more closely, stop and do so. At the completion of this lesson you will be tested on the maintenance, operation and safety procedures contained in it.

GOOD LUCK!

PART I

NAME & FUNCTION OF KEY COMPONENTS

This is part one of the lesson on operation of the 50 GPM pump. This program deals with the names and functions of the engine controls and component equipment of the 50 GPM pumping assembly. At the end of this program when given a 50 GPM pumping assembly and component equipment, you will be able to identify by name and function 7 of any 10 of the engine controls and component equipment indicated by an instructor.

Let's get started! Lift the pump out of the carrying case. It's heavy - so get someone to help you! Place the pump on level ground.

Notice that the pump is made up of three (3) major parts. There is a pump and engine joined together on an oval base.

The pump and engine are close - coupled together. An extension of the engine crankshaft drives the pump.

On the end of the crankshaft and inside the pump housing is a device called the impeller. Product enters the pump through the suction port and is pushed out of the discharge ports by the impeller. You can get a good view of the impeller on the cutaway model of the pump.

Looking at the pump you see four parts. The lowest port is the suction port. Can you find this feature? It points straight out from the pump. Product enters the pump through this port. Next, find the two discharge ports located above the suction port. They point off to the sides. Product leaves the pump through these ports.

At the very top of the pump and pointing straight up is the priming port. You should remove the plug and look into the port just before operation to be sure that the pump body is full of product. WARNING - Never open the priming port when the pump is running!

Look underneath the pump for the drain plug. This plug is opened when it is necessary to remove water or other sediment from the pump body.

Position yourself on the engine side of the assembly, find the gas tank - it's located at the top right hand side of the engine. Just below the gas tank you can see the fuel sediment bowl. This is a device which filters sediment (dirt) from the fuel. Mounted alongside the sediment bowl is the fuel shutoff valve. Do you see it? This valve opens and closes the fuel line from the gas tank to the sediment bowl and carburator.

Find the oil dipstick on the right side of the engine. Remove it and take a look at it - the dipstick indicates the level of oil in the engine crankcase.

Next, staying on the right side, find the speed control lever. It's a lever resting on a notched surface. It's above the dipstick and behind the fuel sediment bowl. Did you find it? ----- The speed control level controls the engine speed and is operated manually.

Move over to the left side of the engines. See the muffler? Next, find the oil bath air cleaner. It's a cup-like basket held in place by a bail wire. Do you see it? Carefully move the bail wire and take the oil bath air cleaner off. Inside the cup should see a small amount of oil. The oil bath air cleaner filters air in the engine.

Follow the line of the oil bath air cleaner. At the top you will find the choke control lever. Do you see it? This lever controls air supply to the engine.

Behind the oil bath air cleaner the magneto assembly is located in a boxlike structure. On the bottom of the magneto is the magneto ignition switch. This switch must be pulled out for the engine to run. Pushing this switch in stops the engine.

Go to the foot of the engine. The pulley starter wheel is at the foot of the engine. The starter rope is wound clockwise around the wheel and pulled sharply to start the engine.

Let's discuss the equipment supplied with the 50 GPM pumping assembly. A metal carrying case is provided with the assembly. You lifted the pump from the inner compartment of this case. Now take the other pieces of equipment from the outer compartment of the carrying case and place them neatly on the ground.

The assembly is provided with the following pieces of equipment: suction hose and discharge hose, suction stub, ground rod and cable and discharge nozzles.

Look at the sections of hose. The suction hose is 1 1/2 inch wire reinforced and noncollapsible. It's hard and will not collapse when you press it. There are two 25 foot sections of this hose. Each section has a male coupling at one end and a female coupling at the other.

The discharge hose is soft to the touch. It is 1 1/2 inch collapsible hose and there are two 50 foot sections. Each section has a male and female coupling.

Next, find the ground rod and cable provided with the 50 GPM pumping assembly. These items are valuable safety features and must be used during operations. You will see more of these items when we set up the assembly for operation.

The suction stub is a long tube like device. Inspect this item. The suction stub is used when sucking fuel out of containers such as 55 gallon drums.

Two discharge nozzles are in brackets on the inside of the carrying case lid. These nozzles are similar to nozzles used at gas stations - however, the nozzles with the 50 GPM assembly are the non-locking type.

You have now completed part one of the lesson on the 50 GPM pump. Review it until you know all the information contained then contact an instructor for further instructions.

PART II

OPERATION OF 50 GPM PUMP

This program is part two of the lesson on the 50 GPM pump. This program describes correct procedures for layout, operator's maintenance and operation of the 50 GPM assembly. At the end of this program when given a 50 GPM pump with hose and fitting kit, and a source of supply you will be able to start, operate and stop the 50 GPM pump; follow all safety procedures, and fill and defuel 5 gallon cans, 55 gallon drums and 500 gallon drums. Sounds like a lot - But you can do it - You'll probably have fun.

The program teaches operation of the pump in the following sequence; procedures for a safety check, procedures for grounding the pump, before operational maintenance, procedures for lay-out of the assembly, correct starting procedures, pumping procedures, and correct shutdown of the assembly.

Before we begin to conduct our pumping operation, remember that you must have proper authorization to conduct any operation. So - be sure you have a DA Form 2404 with you (attached to this program). You complete this form as you move through the operation. If you don't have a DA Form 2404, STOP and see an instructor.

Ready to go? Let's start with safety. There are three (3) major safety precautions to observe when operating the 50 GPM pump. First, you must have a CO_2 type fire extinguisher in the work area. Second, signs which read "No Smoking Within 50 Feet" must be posted in the area. Third, the pump assembly must be grounded using the ground rod and wire.

You ground the assembly by driving the ground rod 36 inches into the ground, then clipping the wire to the ground rod and base of the assembly. Be sure both ends are clipped to bare metal.

Stop now and ground the "50" you're working on. You'll find a hammer to use in one of the tool boxes. Start the program again when you have finished.

How did you do? REMEMBER - grounding the pump is a must do action. It is both a safety precaution and the first step in setting up the equipment for operation!!

You perform BEFORE OPERATIONAL MAINTENANCE after grounding the pump. The following 8 services must be conducted:

(1) Check the discharge nozzles - look for tight connections and proper valve operation. Also check the screen inside to see if it has picked up any contamination. If you see bits of rubber, your hoses might be falling apart and need to be replaced.

(2) Check the discharge hoses - look for leaks, cuts, collapsed walls and gaskets in the quick connectors.

(3) Check the oil level - look at the dipstick, add oil as required.

(4) Check the fuel sediment bowl - tighten if it leaks and clean if it is dirty.

(5) Check the fuel tank - add fuel as required. Do not fill the

tank more than 75% full to allow for expansion of the fuel in hot weather.

(6) Check the oil bath air cleaner - check to see that the oil is clean. Stick your finger down into the cup and see if you can feel any grit or dirt. If so, empty, clean and refill the cup.

(7) Check the starter rope - the rope should not be frayed or damaged.

(8) Check the suction hose - check for leaks, cuts, collapsed walls and gaskets in quick connectors. Be sure connections are tight.

Use the checklist as a guide and pull before operational maintenance on your pump. DO IT NOW!

Once you have performed BEFORE OPERATIONAL MAINTENANCE you are ready to set up the assembly.

OPERATION #1

Follow this procedure for filling 5 gallon cans or 55 gallon drums.

(1) Check quick connectors (female) for good gaskets.

NOTE: These hoses have dust caps and dust plugs on them to keep dirt and contamination out. When you remove these caps and plugs so you can hook up the hoses, don't drag the hoses in the dirt. Try to keep contamination out of the hoses.

(2) Connect the suction hose from the supply source (with elbow coupler valve) to the suction port of the pump assembly.

(3) Connect the discharge hoses to the discharge port of the pump.

(4) Connect the nozzles to the discharge hoses.

STOP now and set up the 50 GPM pump for this operation. Have an instructor check your work when you're finished, when he gives you the go-ahead, start on the program again.

Are you set-up? Good! Now you can prime the pump, start it, and transfer fuel.

To prime the pump open the elbow coupler valve at the source of supply so product will flood the pump body.

STARTING PROCEDURES

To start the pump do the following: close the choke, open the fuel shut off valve, open the speed control lever about 1/2 way, pull the magneto switch down, and wrap the starter rope around the pully wheel and give it a sharp pull! If the engine doesn't start the first time - just repeat the steps with the choke open half way. After the engine starts, let it warm up 3 to 5 minutes before beginning to pump!

Now you try it! Be sure you have an instructor with you for this activity. Start on the program when you're finished.

In an actual operation, you would begin to move product after the pump has been warmed up. This is done in two steps. First - you bleed off any air in the hoses; secondly - you carry out your pumping order. Bleeding off the air in the hoses is very simple. While the engine is warming up - hold the nozzles over a drip pan. Open the nozzles a little by squeezing the handle. When fuel begins to appear all air has been removed from the hoses and the equipment is ready. All you do is increase the engine speed and perform the required operation.

Now fill 5 gallon containers and 55 gallon containers by inserting the nozzle into the opening and fill the containers with the nozzle touching the metal at all times. This prevents build up of static electricity. Five gallon cans should be filled to 1/4 inches below bottom of threads and 55 gallon drums should be filled to 1 1/2 - 2 inches of the top.

During operations, check for any leaks or unusual noises. This is called during operations maintenance.

After you have completed the pumping operation its time to shut down the pump. Decrease the engine speed and shut off fuel source then idle the engine for 3 minutes to cool it down, push up on the magneto ignition switch and close the fuel shut off valve.

OPERATION 2

Follow this procedure for defueling 55 gallon drums using the drum suction stub.

To prevent spills and keep you from having to go back to the company to change clothes you better follow these procedures TO THE LETTER!!

1. Hold the discharge nozzle over a drip pan then open the nozzle to allow the fuel in the discharge hose to drain out. After fuel has stopped flowing:
2. Replace the nozzle with an elbow coupler valve.
3. Remove the elbow coupler valve from the 500 gallon collapsible drum and place over a drip pan then open the valve to drain the suction hose.
4. Replace the elbow coupler valve with a drum suction stub.

5. Pull the hose around and insert the drum suction stub into the opening in the 55 gallon drum.

6. Pull the other hose around and hold the elbow coupler valve over the 500 gallon collapsible drum. Make sure the elbow coupler valve is closed.

7. Start the pump and idle it for 3 to 5 minutes (if cold).

8. Open the elbow coupler valve slightly while holding it over a drip pan. When fuel starts coming out of the valve close it and hook it up to the 500 gallon collapsible drum.

9. Open the elbow coupler valve all the way.

10. Throttle the pump up to operating speed.

11. Look down into the 55 gallon drum, the fuel level in the 55 gallon drum should be going down because the pump is sucking it out through the drum suction stub and pumping it into the 500 gallon drum.

12. When the fuel gets near the bottom of the 55 gallon drum tilt the drum over so that the suction stub can suck as much fuel out of the drum as possible.

13. When the drum is empty idle the pump down, remove the suction stub from the empty drum and place in a drip pan.

14. Close the elbow coupler valve on the 500 gallon collapsible drum.

15. After pump has cooled down at idle for 3 to 5 minutes shut the pump off.

The following procedures are to be followed to drain the system. Don't skip any steps or you'll flood the area and yourself with fuel.

1. With the drum suction stub in the drip pan go to the pump and raise the suction hose as high as you can. Then walk toward the suction stub holding the hose as high as possible.

NOTE: Do this twice or until you don't see any more fuel coming out of the suction stub.

2. Make sure the elbow coupler valve on the 500 gallon collapsible drum is closed then disconnect it from the drum and place it over a drip pan. Open the elbow coupler valve at this time to allow fuel to drain into the drip pan.

3. Follow the hose walking procedure used on the suction hose above.

4. Disconnect the suction hose at the pump and replace dust cap or plug on the pump suction port. Then walk the hose to the drip pan one more time.

5. Do the same to the discharge hose.

6. Remove the suction stub and elbow coupler valves from the hoses and perform after operators maintenance.

OPERATION #3

Follow this procedure for filling 500 gallon collapsible drums.

1. Follow hook-up procedures in Operation #1.

2. Put an elbow coupler valve on the end of the discharge hose (instead of the nozzle use an elbow coupler valve).

3. Follow the starting procedures outlined in Operation #1.

4. After the pump has warmed up, hold the (discharge) elbow coupler valve over a drip pan and open it slightly (turn handle to the left). When fuel appears, close the valve. You have just bled all the air out of the system. Connect the elbow coupler valve to the receiving 500 gallon collapsible drum and open the valve all the way.

5. Bring the pump uo to operating speed and keep an eye on the receiving 500 gallon drum. When it fills up it appears smooth and wrinkle free;

6. Idle pump down and close discharge elbow coupler valve. Then close suction elbow coupler valve.

If you have to pack the assembly away - the hoses must be drained of fuel. Use the following procedures:

1. Disconnect discharge elbow coupler valve from receiving drum and hold over drip pan. Then open the valve. If you have a nozzle instead of an elbow coupler valve on your discharge hose, hold the nozzle over a drip pan and squeeze it open.

2. Raise discharge hose at the pump as high as you can. Walk toward the drip pan holding the hose as high as possible.

NOTE: Do this twice or until you don't see anymore fuel coming out of the elbow coupler valve.

3. Disconnect the suction elbow coupler valve from the fuel source and hold over a drip pan. The open the valve.

4. Follow the "hose walking" procedure you just used on the discharge hose.

5. Disconnect the suction hose at the pump and replace dust cap or plug on pump suction port. Then walk the hose to the drip pan one more time.

6. Disconnect the discharge hose from the pump and replace dust cap or plug on the discharge port. Then walk the hose to the drip pan one more time.

7. Remove elbow coupler valves from the suction and discharge hoses.

Once you stop the engine after your final operation, check all operational features as you did before operations - This is called after operational maintenance.

You must complete entries on DA Form 2404.

After the hoses are drained, pack up the assembly in the carrying case.

This is the end of part two. Make sure you know all the operations and information outlined in Part 1 and 2. When you feel you do - contact an instructor and get ready to take the exam! GOOD LUCK!!

FORWARD AREA REFUELING EQUIPMENT SYSTEM (FARE)

INTRODUCTION

The FARE system is primarily a system designed to be used to rapidly refuel helicopters during combat operations and when in isolated areas and other means of refueling are not available. This lesson will teach you how to correctly set-up, perform operators maintenance, and operate the FARE system.

OBJECTIVES

As a result of this instruction, when provided with a 100 GPM pump and hose assembly, forward area refueling equipment and with a source of supply, the student will be able to:

1. Set-up the FARE system.
2. Perform operators maintenance check on pump and hose assembly.
3. Operate the FARE system in aircraft refueling operations.

LESSON I - Layout and Set-Up of the FARE System

This portion of the program will teach you how to set-up the FARE system. Read the lesson carefully, refer to Figure 1 in the text and practice the procedures. You have been provided the necessary equipment and fuel supply course that you need for this objective. Read the lesson and follow the instructions, if you have trouble with the material, ask your instructor for help. Figure 1 of this text is a typical layout of the FARE system. You will have to refer to this picture when doing the first part of this lesson.

Do the following:

1. Place 500 gallon collapsible drums in position.
2. Connect elbow coupler to each drum (see Figure 1 adapter valve).
3. Connect 1 section of 5 foot suction hose to each elbow coupler valve (see figure 1)
4. Connect butterfly valve and 1 section of 5 foot suction hose together.

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Sep 76
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5. Connect 2 inch Tee "T" fitting with butterfly valve (see Figure 1).

6. Connect 5 foot sections of suction hose from "T" fitting to 100 GPM pump suction port.

NOTE TO STUDENT: Remember suction port of the 100 GPM pump is a 2 inch female coupling. See Figure 1-2 (pump-inlet).

7. Connect 5 foot section of suction hose from pump to inlet port of 100 GPM filter separator.

NOTE TO STUDENT: Discharge port of 100 GPM pump is a 2 inch male coupling and the filter separator/inlet is a female.

8. Connect a 50 foot section of hose from filter separator to Wye "Y" fitting (See fig 1) on discharge side of filter separator.

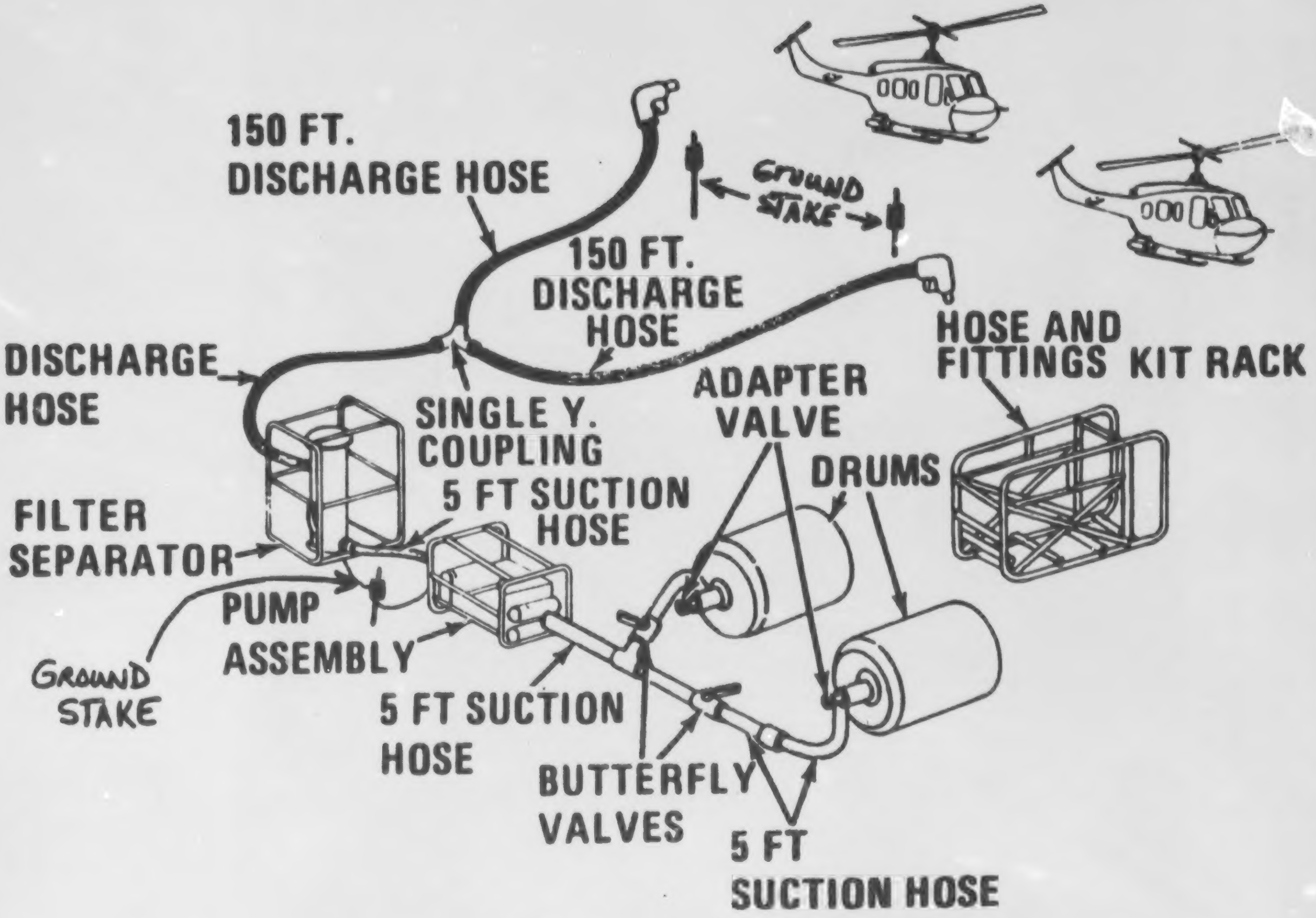
9. Connect two (2) 50 foot discharge hoses from each port of the "Y" fitting, so that it will extend each hose at least 100 feet between the equipment and the aircraft.

10. Connect a nozzle to each end of the 50 foot discharge hose and ground nozzle using the standard grounding rods and cables provided with the system equipment.

11. Ground pump and filter separator using cables and one (1) ground rod (See Figure 1).

12. Remove fire extinguisher from bracket and place it where it can be easily reached in case of fire.

Read these procedures carefully and practice doing them. When you are, satisfied turn the page and do practice exercise.



150 FT.
DISCHARGE HOSE
GROUND STAKE
150 FT.
DISCHARGE HOSE
HOSE AND FITTINGS KIT RACK
DISCHARGE HOSE
SINGLE Y. COUPLING
ADAPTER VALVE
DRUMS
FILTER SEPARATOR
5 FT SUCTION HOSE
PUMP ASSEMBLY
GROUND STAKE
5 FT SUCTION HOSE
BUTTERFLY VALVES
5 FT SUCTION HOSE

PRACTICE EXERCISE

1. How can you determine the discharge port of the 100 GPM pump from the suction port of the pump?

2. The Wye "Y" fitting is placed on what side of the filter separator? Suction or discharge.

3. How many standard grounding rods are needed to ground the 100 GPM pump and the 100 GPM filter separator?

4. Why is it necessary to connect two (2) 50 foot discharge hoses to each port of the Wye "Y" fitting?

Check your answers in discussion 1. If you answered all the questions correctly, go on to the next lesson. If you did not answer all of the questions correctly go back to the beginning of lesson 1 and practice the procedures. Then go to lesson 2.

NOTE TO STUDENT: Turn the page, you will find the answers to the pactice exercise.

266

Discussion - Exercise

1. The discharge port of the 100 GPM pump is a 2 inch MALE coupling, and the suction port is a 2 inch FEMALE coupling.

2. The "Y" fitting is placed on the discharge side of the filter separator on the end of a 5 foot section of suction hose.

3. Only one (1) grounding rod is used to ground the 100 GPM pump and the 100 GPM filter separator, ground cables are connected to each piece of equipment and connected to the ground rod (see Figure 1).

4. Connect two (2) 50 foot discharge hoses to the "Y" assembly so that it will give at least 100 feet between the equipment and the aircraft.

LESSON II - Operator's Maintenance

Now that you know how to correctly set up the FARE system for operation this lesson will teach you the before, during and after operator's maintenance checks. Read the lesson carefully and practice the methods until you can perform the three types of maintenance. If you have trouble with the study material ask your instructor for help.

Before Operators Maintenance Checks.

1. Check fuel in fuel tank, tank should be at least 3/4 full before beginning of operation.

2. Check engine oil level, oil level should read full before operation. (Oil stick located at bottom of engine).

3. Check spark arrestor, make sure it is secure.

4. Check fuel sediment bowl, make sure that it is clean.

5. Check for loose wires and leaks.

6. Check filter separator for proper valve function and leaks.

7. Drain off water if you see any in the sight-glass.

8. Open the air eliminator valve.

9. Fill out TAMMS forms.

During Operators Maintenance.

1. Listen for unusual noises in engine.

2. Check for excessive vibrations.

3. Check for leaks, any evidence of leaks stop operation immediately and repair leak.

4. Monitor PSI pressure gage - if button pops up - stop operation and notify your supervisor.

5. Monitor sight glass - if water appears in it, drain it off.

Practice Exercise

Use the instructions and perform the maintenance procedures step by step until you can do them without using the instructions. If you have problems go back to the beginning of the lesson (lesson 2) and start over. After you feel that you can perform the three types of maintenance checks go to lesson 3.

LESSON III

Now that you have learned the operator's maintenance of the FARE system, the next phase will teach you how to operate the system. The FARE system may be set up to be operated as a two (2) point refueling system (2 nozzles), it can also be set up as a four (4) point system (4 nozzles) when additional equipment is used.

Safety Procedures.

1. Ground unit properly by driving grounding rods into the ground at least 36 inches before connecting grounding cables.

2. Prime pump casing before operation begins, (pour fuel into priming port) be sure to prime pump with type of fuel that you are pumping.

3. Never approach the helicopter from the rear.

4. Always plug bonding cable from nozzle to aircraft before you put nozzle into fuel tank of aircraft.

5. Post no smoking signs on each side of refueling area, signs should be painted in 3 inch letters "NO SMOKING WITHIN 50 FEET."

Operation of the FARE System: follow the procedures below.

OBSERVE SAFETY PRECAUTIONS

1. Layout and set-up the FARE System.

2. Perform operator's maintenance.

3. Start and warm-up the pump.

4. When pump is warmed up open butterfly valve to allow fuel to flow from a 500 gallon collapsible drum.

5. Plug bonding cable from nozzle into aircraft then insert nozzle.

6. After nozzle is inserted, increase engine RPM and begin pumping operation. (Remember to monitor the filter separator operation.)

After aircraft is refuled, close butterfly valve then idle pump down and allow it to cool down. Then:

1. Remove nozzle from aircraft then remove bonding plug.

At this time your instructor will direct the defueling operation (taking the fuel out of the helicopter).

Then: 1. Perform operator's maintenance and complete TAMMS forms.

2. Clean and put away all equipment.

Practice all the procedures contained in this program until you think you know them.

When you feel that you can perform operator's maintenance on, and operate the FARE System to refuel helicopters notify your instructor and take your exam.

TANK & PUMP UNIT

INTRODUCTION:

The Army's continued need for bulk fuel vehicles in large numbers sometimes puts us in situations where shortages of these special vehicles cause requirement problems. When there is a shortage of tank trucks, the Army has a means of converting the common 5- and 2-1/2-ton cargo vehicles into bulk carriers. The 5- and 2-1/2-ton vehicles can be put into service as bulk petroleum carriers very easily by mounting a tank and pump unit on the bed of the truck.

OBJECTIVE:

The student, when provided with two 600-gallon tanks, pumping assembly, and 5- or 2-1/2-ton cargo trucks, will be able to:

1. Install tank and pump unit on 5- or 2-1/2-ton cargo trucks.
2. Know the major components of the tank and pump assembly.
3. Perform operator's maintenance on the tank and pump unit.
4. Operate tank and pump unit in fueling and defueling operations.

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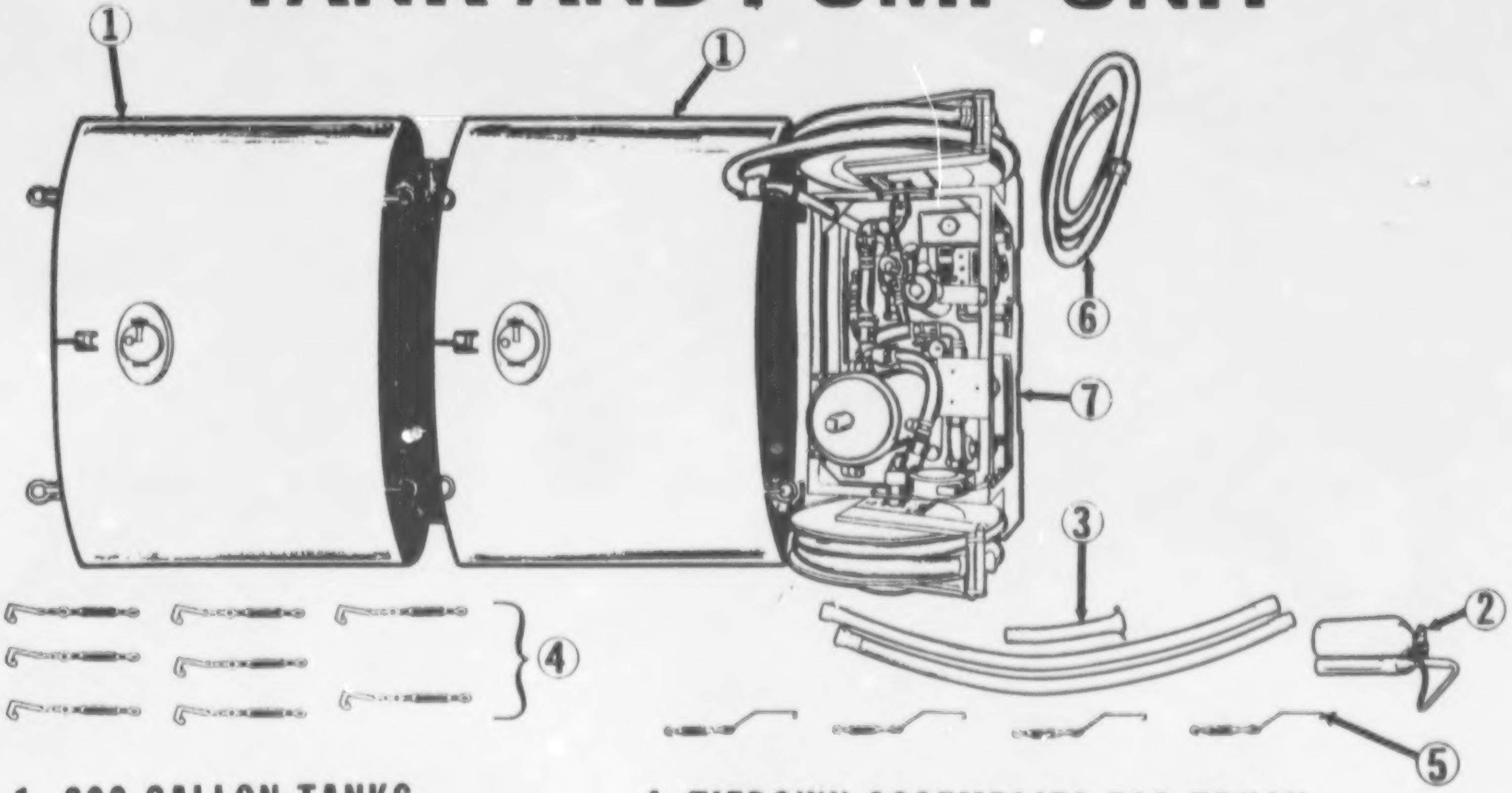
SEPTEMBER 1976

This text is divided into six parts. Part one consists of a series of pictures that describe the methods of mounting the tank and pump on a truck. Part two identifies the major components in the tank and pump unit. Part three is a before, during and after operation check list. Part four discusses the starting and stopping procedure of the engine and the filter separator. Parts five and six are an operational procedure of the two different type units in the Petroleum Training Facility. After this practical exercise you will get an examination. Before going on to "Part I" below, go the the Petroleum Training Facility where an instructor will assign a unit to you. Follow your instructions carefully.

PART I

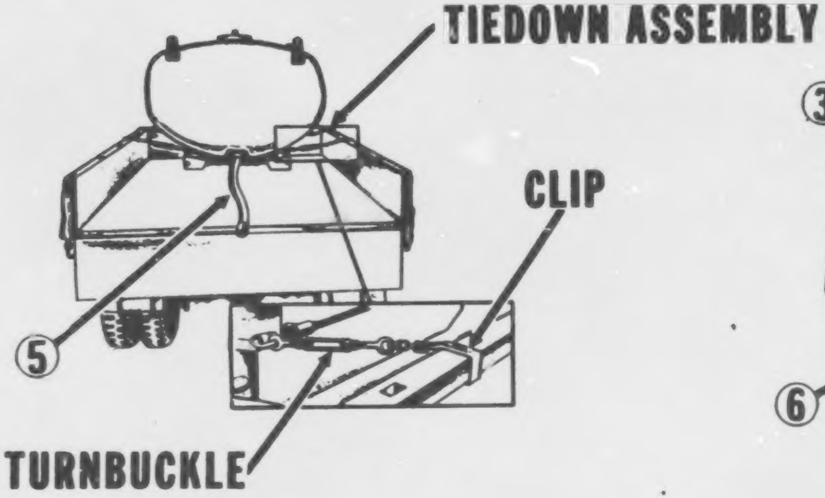
The pictures on the next four pages describe how the tank and pump unit is mounted. Study the pictures and compare them to the unit you are going to work with. Then go on to Part II.

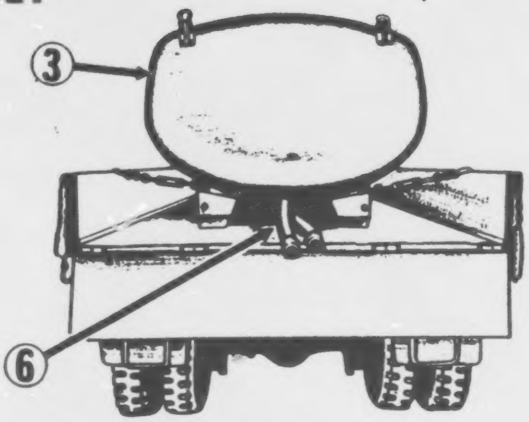
TANK AND PUMP UNIT

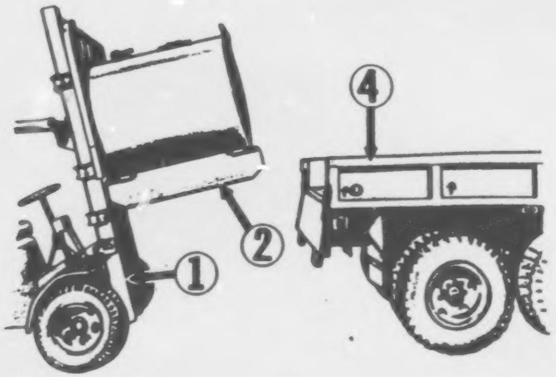


1. 600 GALLON TANKS
2. FIRE EXTINGUISHER
3. SUCTION HOSES, & METER HOSE (SHORT SECTION)
4. TIEDOWN ASSEMBLIES FOR TRUCK
5. TIEDOWN ASSEMBLIES FOR TRAILER
6. GRAVITY DISPENSING HOSE FOR TANK UNIT
7. PUMPING ASSEMBLY

INSTALLING TANKS


TIEDOWN ASSEMBLY
CLIP
⑤
TURNBUCKLE

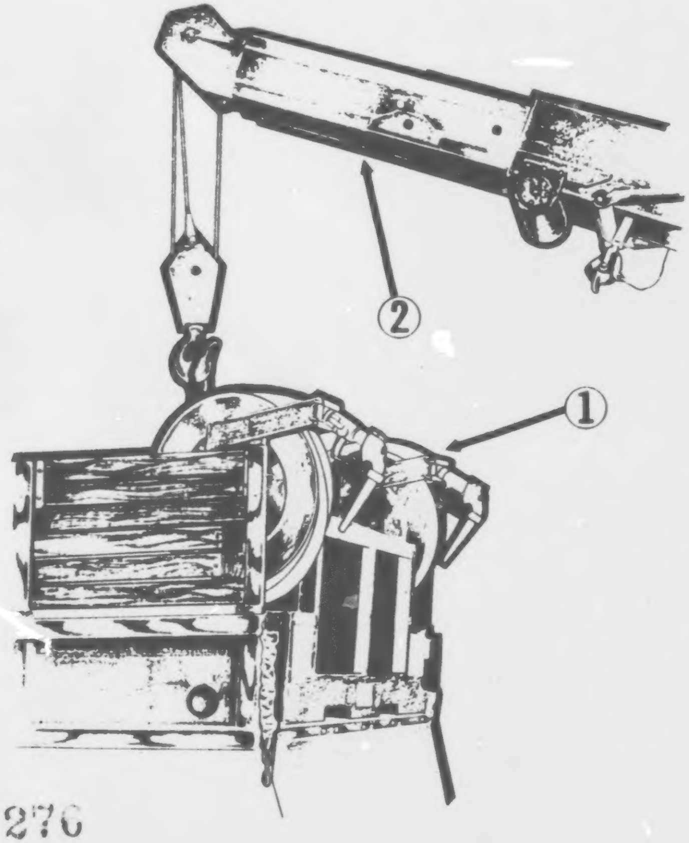




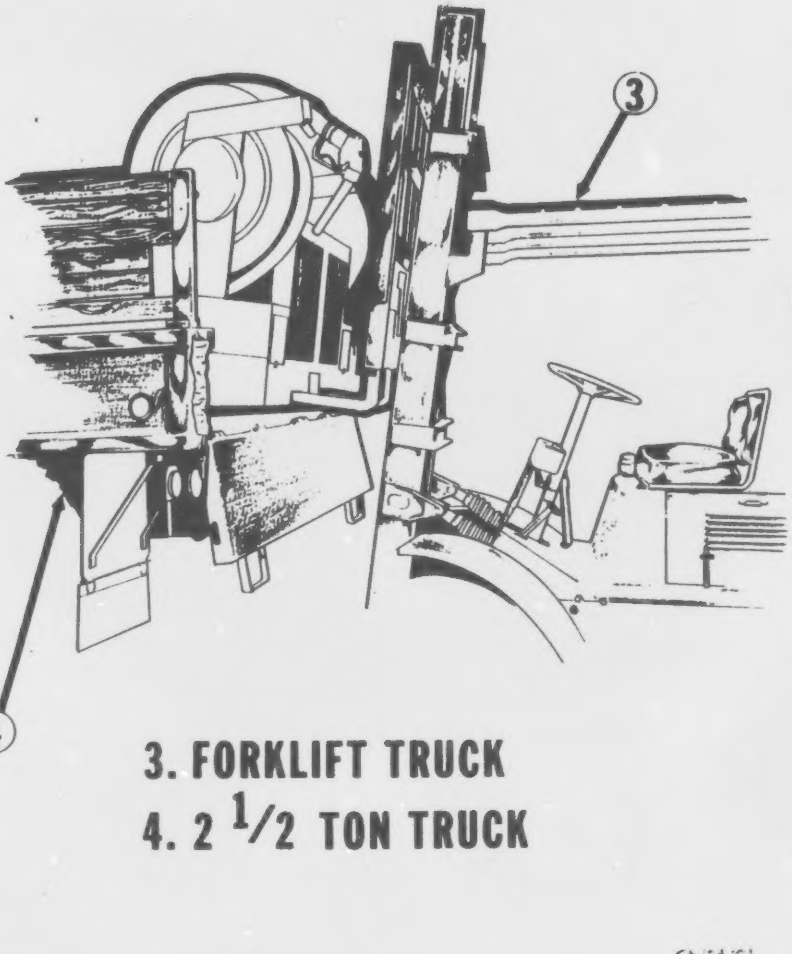
1. FORKLIFT TRUCK, (WRECKER OR OTHER LIFTING DEVICE)
2. FRONT TANK
3. REAR TANK
4. 2 1/2 TON TRUCK
5. SUCTION HOSE (107")
6. SUCTION HOSE (44")

INSTALLING PUMPING ASSEMBLY

1. PUMPING ASSEMBLY
2. 5 TON WRECKER



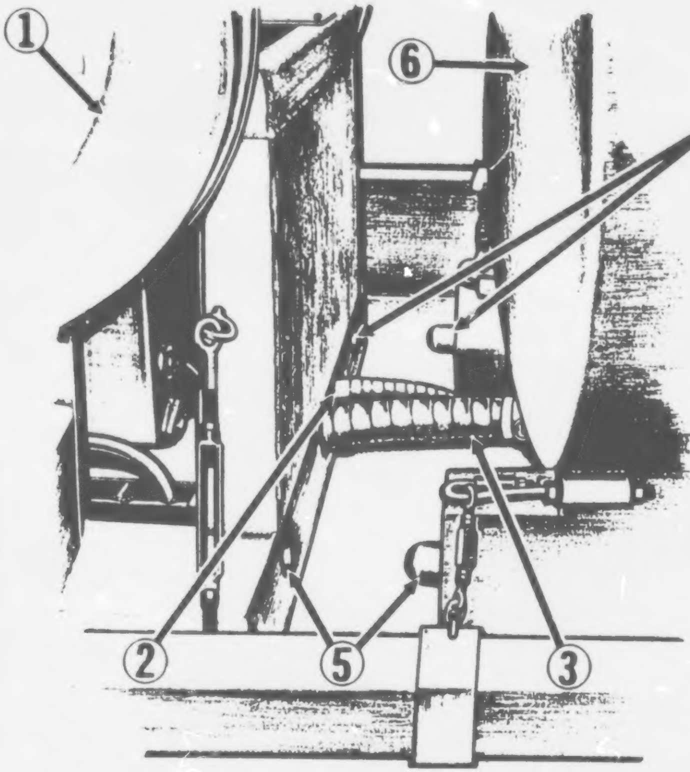
276

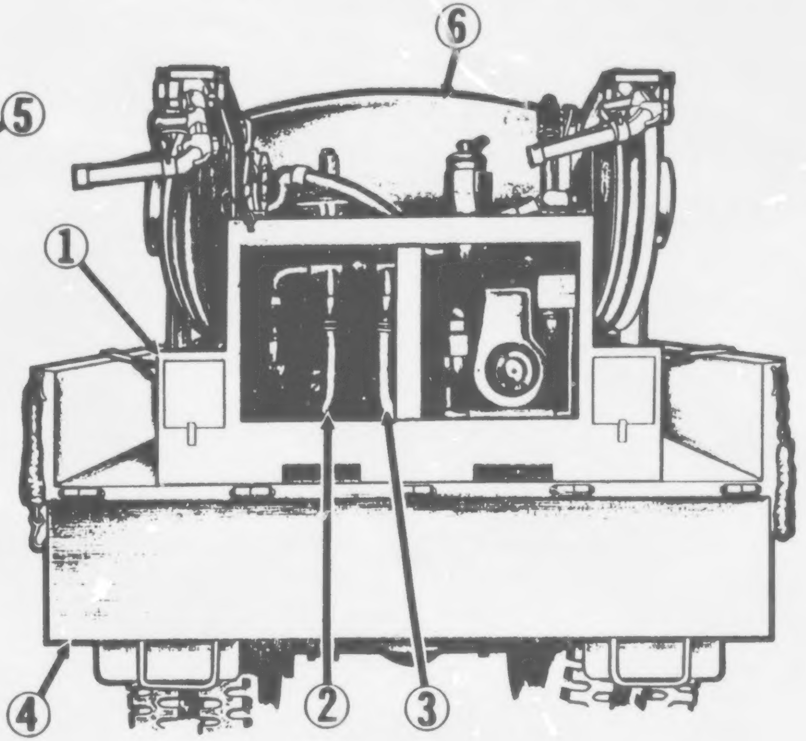


3. FORKLIFT TRUCK
4. 2 1/2 TON TRUCK

277

INSTALLING PUMPING ASSEMBLY (CONT.)





1. PUMPING ASSEMBLY
2. SUCTION HOSE (107 INCH)
3. SUCTION HOSE (44 INCH)
4. 2 1/2 TON TRUCK
5. INTERLOCKS
6. REAR TANK

PART II

INSTRUCTION:

This lesson will identify major parts and teach you how to operate the unit. You see before you the tank and pump unit mounted on the bed of a 2-1/2-ton cargo truck. A brief description of the important parts of the unit is below. NOTE: Refer to the pictures inclosed in this program to locate the items.

MAJOR PARTS:

600-Gallon Tank

#1 Drain Valve Handle - Located between filler plug and dip stick. NOTE: Do not pull drain valve handle.

#2 Pump Port Dip Stick - Top and rear of tank. NOTE: Pull the dip stick out; you see that it is numbered every hundred and marked every 25 gallons.

#3 Drain Valve - This valve is only used when you have to empty the tanks in an emergency. It is operated by item #1.

#4 Discharge Valve - Lever (#5) opens and closes this valve; it lets fuel flow out of the tank and enter the pumping assembly.

#5 Discharge Lever - Front of tank. NOTE: Pull lever up to open.

#6 Filler Plug - Located center of tank top.

PUMPING ASSEMBLY:

Pump - 50 GPM pump, operator's maintenance is the same as on any 50 GPM pump.

Filter Separator - The 50 GPM separator is located to the left rear of the pumping assembly frame. Both solids, contaminants, and water are removed from products through filtering elements located inside the separator. An air eliminator is located at the top of the separator for bleeding air out of the system. The sight glass (glass tube on the side of the separator) provides visual observation of water and product in the separator. When water appears in the sight glass (in lower portion), open the manual water drain on the bottom of separator to drain it off.

Ground Rod - A ground rod assembly is attached to the frame of the pumping assembly and is to be used for grounding the tank and pump unit. A 40-foot "Y" cable on a spring loaded reel is included for grounding and bonding aircraft. NOTE: To operate cable, pull cable out, attach to ground rod (rewind by giving cable a short jerk).

Hose Reel - There is a hose reel on each side of the pump unit. Each hose is approximately 40-feet long. The hose is made of noncollapsible synthetic rubber and is 1-1/2 inches in diameter. The hoses are equipped with 1-1/2 inch nozzles.

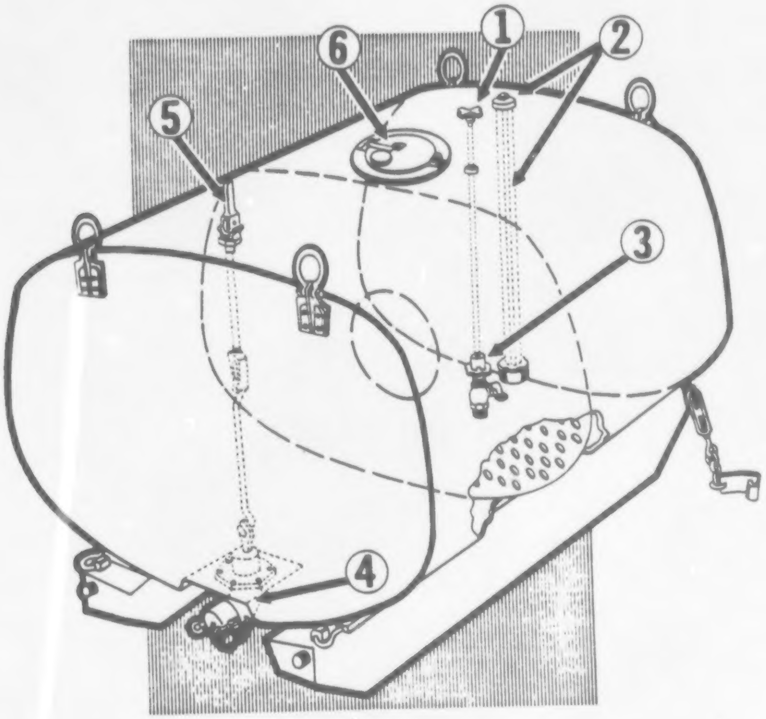
Fire Extinguisher - Always place fire extinguisher within easy reach before any operation.

Manifold - On some models, a 3-way valve is provided to control the flow of product in and out of the pumping assembly. The operation of this valve will be explained later in this program.

Discussion:

The key components you have just seen play an important role in operation of the tank and pump unit, but before you can operate any equipment, operator's maintenance must be performed.

279

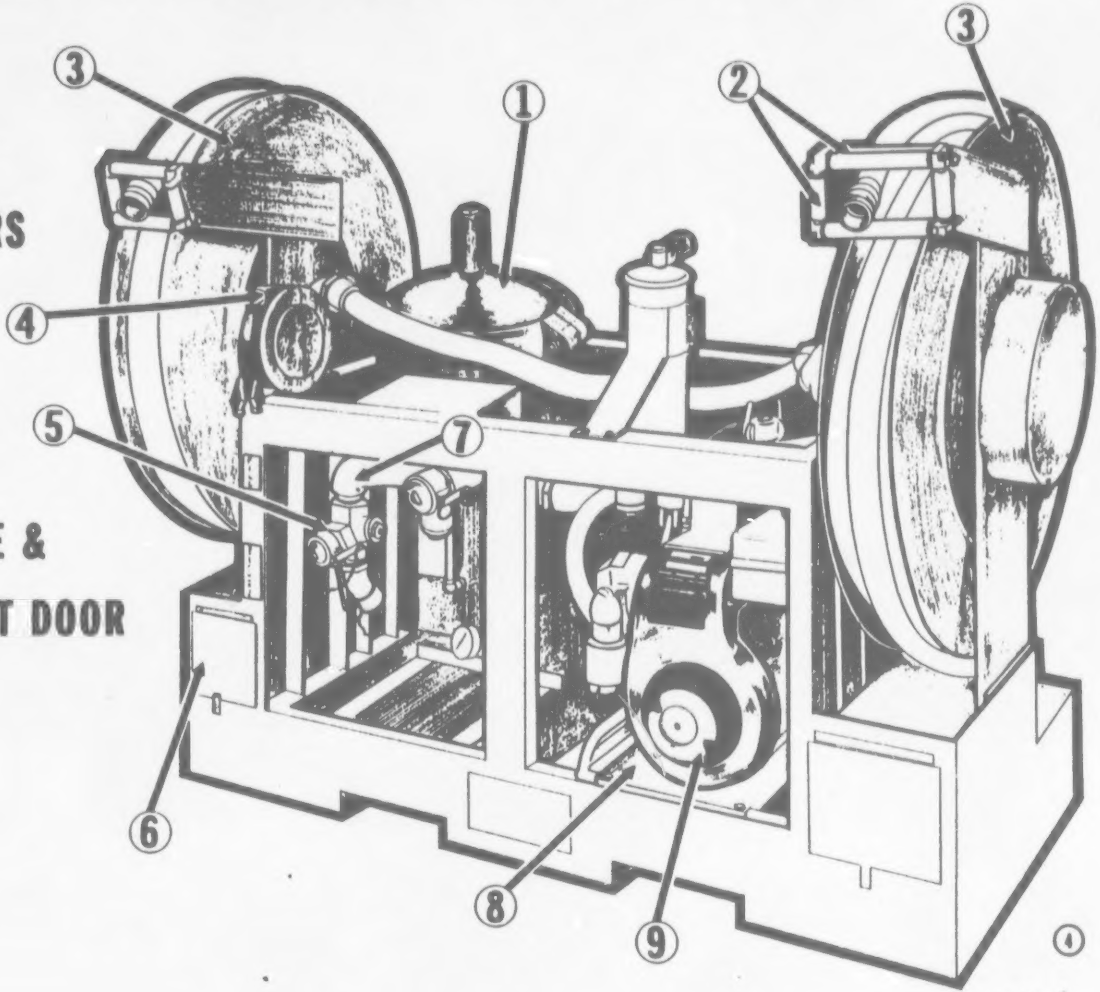


1. HANDLE 2. PUMP PORT & DIP STICK 3. DRAIN VALVE

4. DISCHARGE VALVE 5. LEVER 6. FILLER PLUG

PUMPING ASSEMBLY

1. FILTER-SEPARATOR
2. HOSE GUIDE ROLLERS
3. HOSE REEL
4. GROUND REEL
5. 3-WAY VALVE
6. INSTRUCTION PLATE & TOOL COMPARTMENT DOOR
7. MANIFOLD
8. BASE PLATE
9. ENGINE



PART III

This part of the lesson will be concerned with the operator's maintenance which must be performed before, during and after operation. Here are the maintenance checks you are required to perform as an operator of the tank and pump unit.

BEFORE OPERATIONAL MAINTENANCE:

1. Check logbook and make required entries on TAMMS forms.
2. Check crankcase oil and oil bath air cleaner.
3. Check fuel level.
4. Check fire extinguisher seal and tag.
5. Check ground reel assembly for worn or frayed cable and clips.
6. Check hose for crack wear and make sure nozzle screen is clean.
7. Check tank and pump unit in general for obvious deficiencies (loose nuts, bolts, etc).
8. Recirculate the fuel in each tank for 5 minutes (see instructor).

DURING OPERATIONAL MAINTENANCE:

1. Check for unusual noises.
2. Check for excessive vibrations.
3. Check for leaks.
4. Check filter separator for water and pressure differential (see instructor).

AFTER OPERATIONAL MAINTENANCE:

1. Refuel the 50 GPM pump.
2. Add crankcase oil if necessary.
3. Clean and put away all equipment.
4. Fill out TAMMS forms.

Discussion:

If you follow the procedures listed previously, you should have no problems. Learn them well! You are now ready to start your pump.

PART IV

STARTING AND STOPPING THE PUMP:

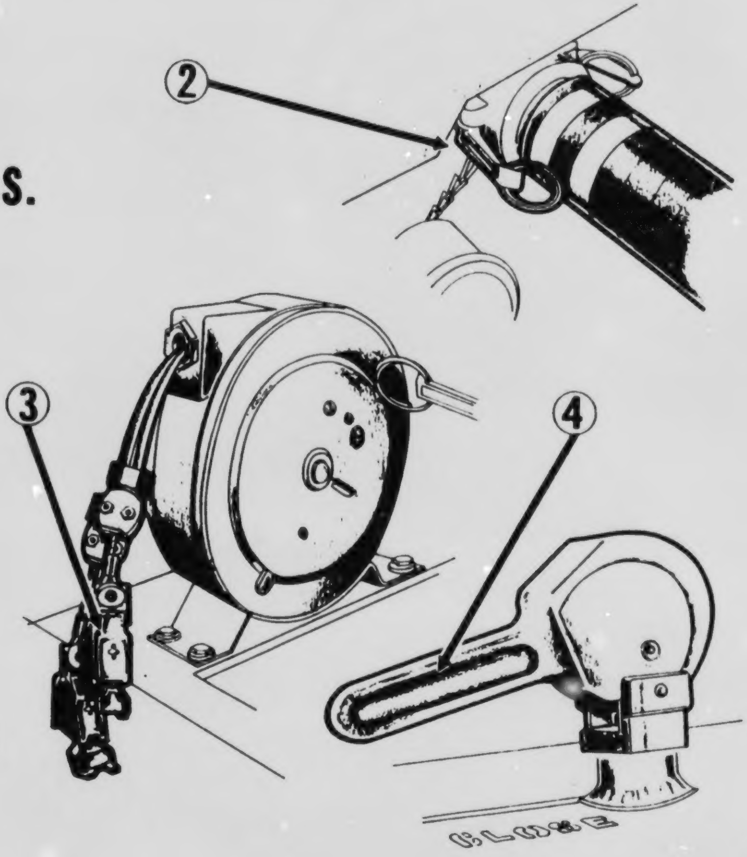
This engine and pump is basically the same as the 50 GPM pump you operated in the last block of instruction. You may use the illustrated directions on the next three pages for correct procedure in starting and stopping the pump.

FILTER SEPARATOR:

Prior to dispensing operations the fuel should be recirculated in each tank for five minutes. During this time you would check for pressure differential to see if the filters need to be replaced. You would also check the sight glass for water and drain off any water collected. Your instructor will point this out for you.

STARTING PUMP ENGINE ASSEMBLY

1. REMOVE SHROUD OR CLOTH FROM PUMPING ASSEMBLY.
2. CHECK SUCTION HOSES FOR TIGHTNESS.
3. GROUND:
   - A. VEHICLES; BY ATTACHING BOTH CLIPS TO IRON STAKE IN GROUND.
   - B. AIRCRAFT; BY ATTACHING ONE CLIP TO IRON STAKE, & SECOND CLIP TO AIRCRAFT.
4. KEEP TANK DISCHARGE VALVE CLOSED DURING WARMUP OPERATIONS.

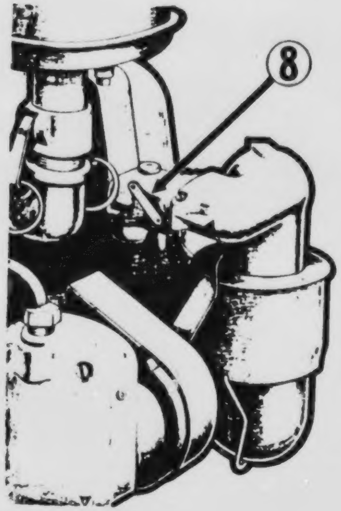


STARTING PUMP ENGINE ASSEMBLY (CONT.)

5. REMOVE DUST CAP. FILL PUMP WITH PRODUCT (IF NECESSARY), REPLACE CAP.

6. CHECK ENGINE CRANKCASE FOR PROPER OIL, & LEVEL.

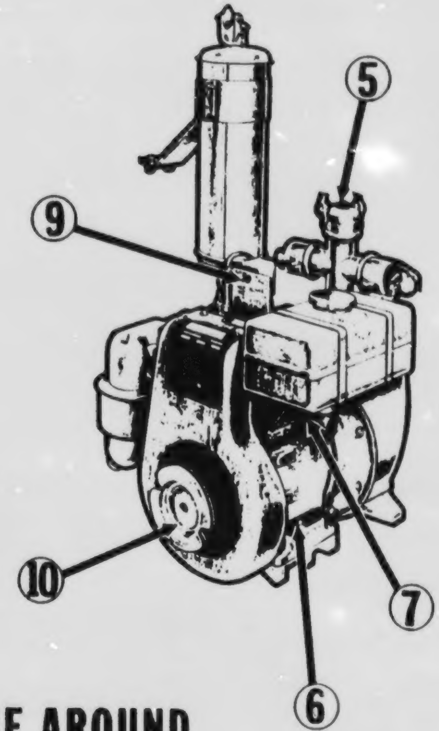
7. OPEN PETCOCK ON BOTTOM OF FUEL TANK.



8. CLOSE CARBURETOR CHOKE.

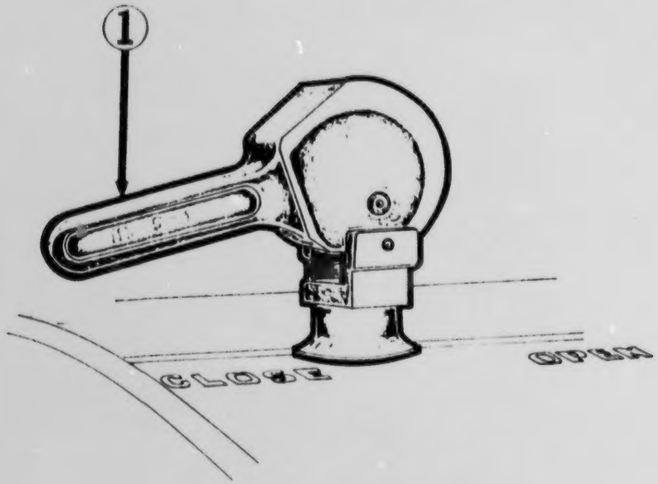
9. PUSH IN IGNITION SWITCH.

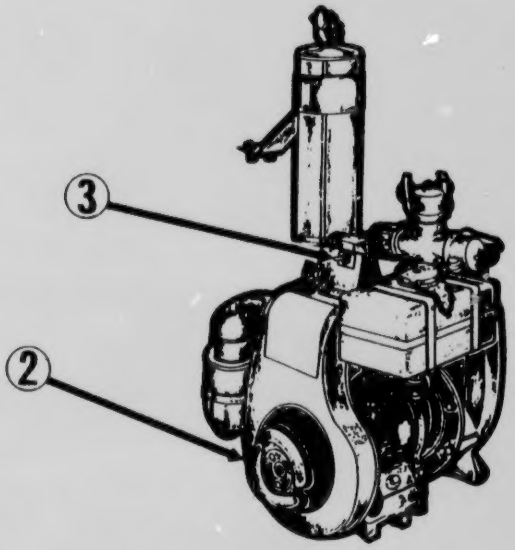
10. WIND STARTER ROPE CLOCKWISE AROUND PULLEY, & PULL TO START.



STOPPING PUMP ENGINE ASSEMBLY

1. CLOSE TANK DISCHARGE VALVES.
2. ALLOW ENGINE TO OPERATE 3 TO 5 MINUTES AT LOW SPEED.





3. PULL OUT IGNITION SWITCH.
4. REPLACE SHROUD OR CLOTH ON PUMPING ASSEMBLY.

PART V

Dispensing Operations For Unit "A":

There are two (2) different tank and pump units in the Petroleum Training Facility. This part (Part V) is only for Unit "A". If you were assigned Unit "B" turn to Part VI now and follow instructions. If you were assigned Unit "A" then read all of Part V first then come back to this page and follow the instructions closely.

You will perform five specific operations in this PE. For all five operations the following steps of preliminary action are standard.

1. Set out your fire extinguisher.
2. Attach ground cable to ground rod.
3. Perform "Before Operations Maintenance."
4. Gage the tanks.

NOTE: Operation of the tank and unit is normally a two man operation. You are working now with a buddy. During your examination you will be tested on every part of the operation so make sure you understand every detail of the operation as you work together.

OPERATION #1 - Recirculating the Fuel

1. Open filler plug.
2. Reel out enough hose and hold nozzle in the filler port.
3. Make sure 3-way valve handle is straight down.
4. Open tank valve.
5. Start the engine.
6. Open nozzle valve.
7. Increase engine speed 5 clicks.
8. Check pressure differential while pumping.
9. Idle pump down.
10. Close nozzle and tank valves.
11. Stop pump.
12. Perform after operations maintenance.

OPERATION #2 - Filling 55 Gallon Drums

Operation of the unit for filling drums is exactly the same as in Operation #1 except for the following.

1. Place drum on end with bungs up.
2. Inspect drum for holes or contamination.
3. Maintain metal to metal contact between nozzle and drum while filling.
4. Fill drum to 1-1/2 to 2 inches from the top.

OPERATION #3 - Filling 500 Gallon Collapsible Drums

Operation of the unit for filling 500 gallon collapsible drums is exactly the same as in Operation #1 with the following exceptions.

1. Before starting the pump, hold the nozzle over the open filler port and carefully remove the nozzle assembly and attach the elbow coupler valve. Be careful not to drop either assembly into the tank.
2. While the pump is idling hold the elbow coupler valve over the open filler plug and open the valve about halfway. Bleed all the air out of the line, then close the valve.
3. Attach elbow valve to empty collapsible bag and fill.
4. DO NOT OVERFILL THE DRUM. Be sure to idle the pump and close nozzle and tank valves when the last wrinkle (or dent) disappears from the drum.

OPERATION #4 - Defueling 55 Gallon Drums

1. Turn 3-way valve handle to the right.
2. Attach 1 1/2 inch suction hose to the 1 1/2 inch suction port of the manifold.
3. Attach defueling tube to the suction hose and insert into drum to be emptied.
4. Open filler plug.
5. Hold nozzle over open filler port and open the nozzle. KEEP THE NOZZLE OPEN.
6. Increase engine speed 5 clicks.
7. Turn 3-way valve handle straight down.
8. If the pump loses prime or fails to pull the fuel out of the drum, open the TANK VALVE. Leave the valve open only until the pump picks up prime and starts pumping, then close the TANK VALVE.
9. When the drum is empty, point the defueling tube high over your head, then walk the line back to the manifold. Walk the line back twice.
10. After walking the line back twice and while still keeping hose high turn the 3-way valve handle to the right.
11. Idle the pump down.
12. Place drip pan under defueling tube and drain hose line completely.
13. Stop the pump.
14. Replace all equipment.

OPERATION #5 - Defueling 500 Gallon Collapsible Drums

Operation of the tank and pump unit for defueling 500 gallon collapsible drums is exactly the same as in operation #4 except for the following.

1. Use elbow coupler valve instead of the defueling tube.
2. Keep elbow valve closed until firmly attached to the drum.
3. Keep elbow valve open when walking the line.

NOTE: After completing any operation be sure to perform the following.

1. Close filler plug.
2. Gage tanks.
3. Perform after operations maintenance.

Perform all five operations and when you are confident you understand them all tell your instructor you are ready for your exam.

PART VI

Dispensing Operations for Unit "B":

This part (Part VI) is only for Unit "B". If you were assigned to Unit "B" then read all of this Part VI first then come back to this page and follow instructions closely.

You will perform five specific operations in this PE. For all five operations the following steps of preliminary action is standard.

1. Set out your fire extinguisher.
2. Attach ground cable to ground rod.
3. Perform "Before Operations Maintenance."
4. Gage the tanks.

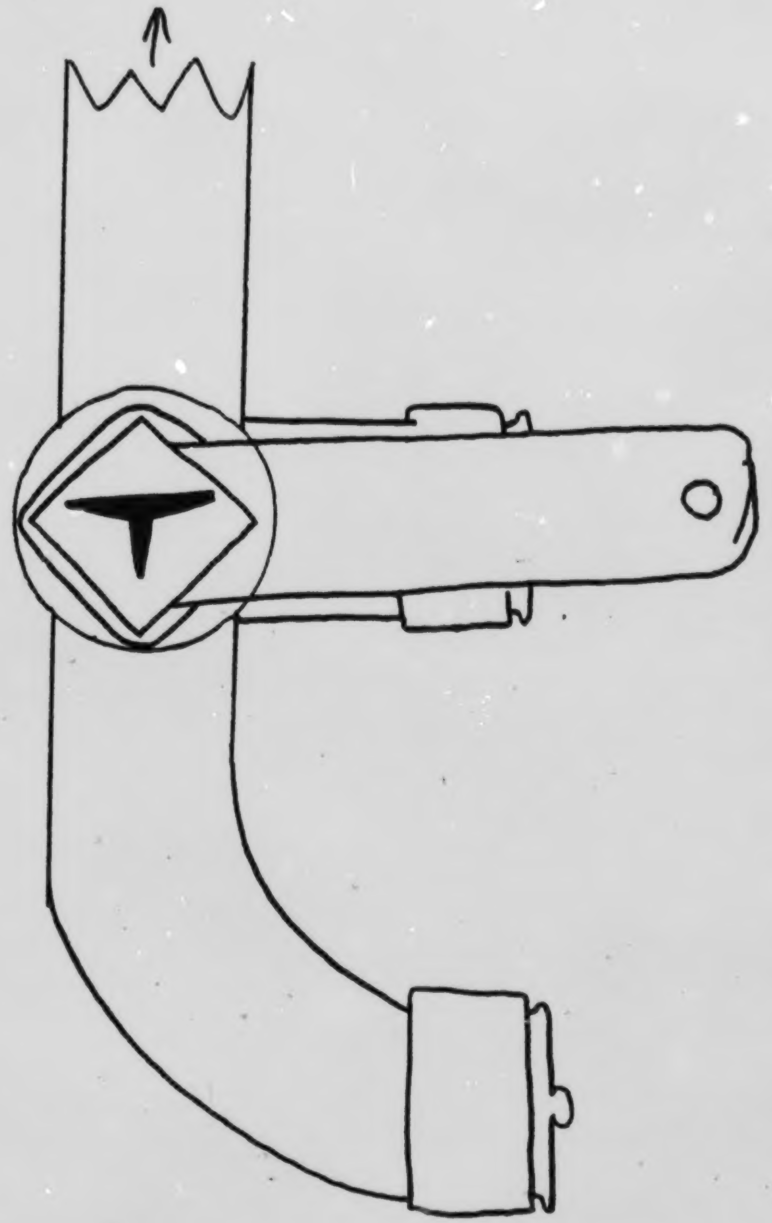
NOTE: Operation of the tank and pump unit is normally a two man operation. You are working now with a buddy. During your examination you will be tested on every part of the operations so make sure you understand every detail of the operation as you work together.

3-WAY VALVE

Before going on to your first operation put the 3-way valve handle on the 3-way valve exactly as you see it on the next page.

3-WAY

VALVE HANDLE ATTACHED



"UP"
POSITION

OPERATION #1 - Recirculating the Fuel

1. Open filler plug
2. Reel out enough hose and hold nozzle in the filler port.
3. Make sure 3-way valve handle is "UP".
4. Open tank valve.
5. Start the engine.
6. Open nozzle valve.
7. Increase engine speed 5 clicks.
8. Check pressure differential while pumping.
9. Idle pump down.
10. Close nozzle and tank valves.
11. Stop pump.
12. Perform after operations maintenance.

OPERATION #2 - Filling 55 Gallon Drums

Operation of the unit for filling drums is exactly as in Operation #1 except for the following.

1. Place drum on end with bungs up.
2. Inspect drum for holes or contamination.
3. Maintain metal to metal contact between nozzle and drum while filling.
4. Fill drum to 1 1/2 to 2 inches from the top.

OPERATION #3 - Filling 500 Gallon Collapsible Drums

Operation of the unit for filling 500 gallon collapsible drums is exactly as in Operation #1 with the following exceptions.

1. Before starting the pump, hold the nozzle over the open filler port and carefully remove the nozzle assembly and attach the elbow coupler valve. Be careful not to drop either assembly into the tank.

2. While the pump is idling hold the elbow coupler valve over the open filler plug and open the valve about halfway. Bleed all the air out of the line, then close the valve.

3. Attach elbow valve to empty collapsible bag and fill.

4. DO NOT OVERFILL THE DRUM. Be sure to idle the pump and close nozzle and tank valves when the last wrinkle (or dent) disappears from the drum.

OPERATION #4 - Defueling 55 Gallon Drums

1. Leave the 3-way valve handle "UP.
2. Attach 1 1/2" suction hose to the 1 1/2" suction port of the manifold.
3. Attach defueling tube to the suction hose and insert into drum to be emptied.
4. Open filler plug.
5. Hold nozzle over open filler port and open the nozzle. KEEP THE NOZZLE OPEN.
6. Increase engine speed 5 clicks.
7. Turn 3-way valve handle straight down.
8. If the pump looses prime or fails to pull the fuel out of the drum, open the TANK VALVE. Leave the valve open only until the pump picks up prime and starts pumping, then close the TANK VALVE.
9. When the drum is empty, point the defueling tube high over your head, then walk the line back to the manifold. Walk the line back twice.
10. After walking the line back twice and while still keeping hose high turn the 3-way valve handle "UP".
11. Idle the pump down.
12. Place drip pan under defueling tube and drain hose line completely.
13. Stop the pump.
14. Replace all equipment.

OPERATION #5 - Defueling 500 Gallon Collapsible Drums

Operation of the tank and pump unit for defueling 500 gallon collapsible drums is exactly the same as in Operation #4 except for the following.

1. Use elbow coupler valve instead of the defueling tube.
2. Keep elbow valve closed until firmly attached to the drum.
3. Keep elbow valve open when walking the line.

NOTE: After completing ANY operation be sure to perform the following.

1. Close filler plug.
2. Gage tanks.
3. Perform after operations maintenance.

Perform all five operations and when you are confident you understand them all, tell your instructor you are ready for your exam.

299

EQUIPMENT INSPECTION AND MAINTENANCE WORKSHEET

For use of this form, see TM 38-750; the proponent agency is the Office of the Deputy Chief of Staff for Logistics.

1. ORGANIZATION				2. NOMENCLATURE AND MODEL		
3. REGISTRATION/SERIAL/FSN	4a. MILES	b. HOURS	c. ROUNDS FIRED	d. HOT STARTS	5. DATE	6. TYPE INSPECTION

7. APPLICABLE REFERENCE

TM NUMBER	TM DATE	TM NUMBER	TM DATE

INSTRUCTIONS - Perform each check listed in the TM applicable to the inspection performed. Following the sequence listed in pertinent TM, complete form as follows:

COLUMN a - Enter TM item number.

COLUMN b - Enter the applicable condition status symbol.

COLUMN c - Enter deficiencies and shortcomings.

COLUMN d - Show corrective action for deficiency or shortcoming listed in Column c.

COLUMN e - Individual ascertaining completed corrective action initial in this column.

ALL INSPECTIONS AND EQUIPMENT CONDITIONS RECORDED ON THIS FORM HAVE BEEN DETERMINED IN ACCORDANCE WITH DIAGNOSTIC PROCEDURES AND STANDARDS IN THE TM CITED HEREON.

8a. SIGNATURE *(Person(s) performing inspection)*	8b. TIME	9a. SIGNATURE *(Maintenance Supervisor)*	9b. TIME	10. MANHOURS REQUIRED

TM ITEM NO. a	STATUS b	DEFICIENCIES AND SHORTCOMINGS c	CORRECTIVE ACTION d	INITIAL WHEN CORRECTED e

SAMPLE

DA FORM 1 JAN 64 2404

300

QMS 300.596-1 H2

U. S. ARMY QUARTERMASTER SCHOOL

HANDOUT

TANK AND PUMP UNIT
BETA SYSTEMS MODEL

PROPONENT DEPARTMENT: Petroleum & Field Services

November 1977

PART I

INTRODUCTION

There are approximately 11 different models of the tank and pump unit in the field. The two models which you studied in detail in your programed text are two of the most common models found in the field. The newest gasoline powered model is the Beta Systems Model There is still a newer model being developed which has an electric motor. (This model is not yet in the field).

In the study area in building 11400, you will find the pump assembly portion of the Beta System Model. This model is an easier model to operate than the two models you just studied. If you understand those, then this one is a "cinch".

Go to the study area in 11400 and begin Part II of this handout.

Before, during and after operations maintenance, as well as safety requirements, are the same for all models. Therefore, it is important to learn the differences between the models. Look at the model in building 11400 and check each item below. Look at the differences between this model and the others.

1. Note the hose reels are the same and that the nozzles have the jacks needed for aircraft refueling.

2. The ground wire reel is spring wound and located just to the right of the left hose reel.

3. Just below the ground wire reel you see a large compartment which opens to the front. This can be used to store extra hose and fittings, rags, or any equipment needed for your operation.

4. Just to the right of the storage compartment there is a space for setting a five gallon gasoline can. Note the suction stub and adaptor. On the other models you had a one gallon gas tank. This model makes it easy to switch from an empty tank to a full tank with no pouring required.

5. In the center of the assembly is the filter separator. The water float sight glass is located on the front near the bottom of the separator. If the float reaches the black mark on the sight glass you must drain the water. The water drain is the "pet-cock" valve just to the left of the sight glass.

6. The pressure differential gage on this filter separator actually shows the pounds of differential pressure between the inlet and outl et side of the filter separator. REMEMBER: On this type gage the fuel must be flowing out the nozzle under pressure when you check the pressure differential.

7. Notice there is no three (3) way valve on this model. Look at the hoses under the filter separator. They come from the tank compartments to the intake manifold.

8. Note the two inch female port with dust plug on this manifold. This port can be used for suction or for gravity discharge. (Your instructor will show you how to do this during your PE.)

9. The pump and motor are basically the same as the other units except for four things:

a. Look on top of the pump and you see a 1 1/2 inch male port with dust cover. This can be used as a priming port or a 1 1/2 inch discharge hose can be attached here to by-pass the filter separator. (This is only done for special operations which you won't be required to know at this time.)

b. The magneto switch is located on the fly-wheel cover.

c. The oil dip stick is located on the left side of the engine under the "snap lock cap". Check this now!

d. This unit is equipped with a crankcase oil drain which makes it easy to change oil. You can see this drain pipe at the bottom left of the engine.

10. The fuel goes directly from the pump to the filter separator and from the filter separator directly to the hose reels. To pump fuel from one of the tanks through the hose reels, you need only to open the tank discharge valve, start the pump, connect the ground wire and squeeze the nozzle.

NOTICE

Remember all the safety rules and maintenance you learned in your programed text. They apply to this unit as well.

PART III

After you have familiarized yourself with the unit in building 11400, advise your "C" Annex control manager that you are ready for your practical exercise on the Tank and Pump Unit. If you have any questions be sure to ask your instructor.

GOOD LUCK

INTRODUCTION

There are many times in combat situations when more fuel is needed than the 50 GPM pump can deliver. Also the Army needed a large pump that was fully portable. This is why the Army now uses the 350 GPM pump.

OBJECTIVE

You will be able to: (1) Perform operational safety and maintenance checks. (2) Operate the 350 GPM pump.

HOW TO USE THIS PROGRAM

All of the directions for you to follow are in this program. Part I is an audio tape dealing with the general description and components involved with the fuel flow of the 350 GPM pump. Part II is also an audio tape and discusses the components of the control panel, their names, functions and operations. Part III deals with operators maintenance: both the components to be checked and the procedures to follow. Part IV is the starting and stopping phase where you will actually practice starting/stopping and operating the 350 GPM pump. Part V is the test on (1) Operator's safety and maintenance. (2) Operation of the 350 GPM pump.

As you complete each part of this lesson, do as the directions at the end of each part tell you.

See your instructor at this time and tell him you are ready to begin your study of the 350 GPM pump.

PROPONENT DEPARTMENT: Petroleum and Field Services
November 1976

THIS SUPERSEDES QMS 300.663H1 DTD SEPTEMBER 1976.

350 PUMP - PART 1 (Audio Tape)

This is the 350 GPM pump. It is a part of the FSSP, but can be used anytime a greater pumping rate is required than the 50 GPM pump can deliver.

This tape will describe and acquaint you with all the features of this pump that you'll need to know in order to operate it effectively. Some of the components are numbered or colored for ease of identification.

Please stand on the spot marked X and move around the pump following the directions given in the program.

If at any time you want to stop and look more closely or operate one of the items referred to in the program, stop the tape and restart it when you're ready to continue.

READY?? Projecting from the pump at knee height is the tow bar. The tow bar is connected to a towing vehicle to enable you to move the pump from place to place for short distances.

Directly above the tow bar are two gate valves and 4" ports. The valves are painted green. These are the suction ports and valves for this pump. Notice that these valve stems rise when the valves are opened and fall when the valves are closed. Trace the flow of fuel into these ports and you'll notice they lead to assembly number 4. This is the fuel strainer. This strainer assembly removes all sediment and trash from the fuel before it gets to the pumping assembly and causes damage to impellers.

Follow the flow arrows. You see that beyond the strainer assembly the fuel enters the pump body. It leaves the pump body thru the port at the top.

The small valve numbered 6 directly above the pump body is the air vent valve. By opening this valve prior to operation, air is bled out of the pump body. We'll return to this feature later in the program.

At this time, walk around to the other side of the pump and stand on spot marked #1. Following the flow beyond the air vent valve, the next feature we come to is the priming check valve. See the handle? Just as you learned when studying the 50 GPM pump, this valve prevents fuel from flowing back into the pump body once it has passed this valve. By looking from a distance you can tell if fuel is being discharged from the pump by noting the position of the handle: when fuel is flowing thru, the handle is up, when fuel is not flowing, the handle will be in the position you now see it.

Follow the flow further and you see that it ends at two red rising stem gate valves. These are the discharge valves and ports.

Stop the tape and see if you can identify by name and function the components we have seen to this point. If you have any problems, replay the tape and consult figure 1 in your lesson booklet.

When you think you know all the material that has been discussed, turn on the tape for the next part of your lesson.

PART II (AUDIO TAPE)

This portion of your lesson will deal with the control panel. Let's see what the components of this panel are, what they do and what they mean to you as the operator.

On the upper right corner of the panel is the Engine Oil Pressure Gage. This gage registers engine oil pressure. It should read approximately 5 - 7 pounds per square inch (PSI) at idle and 40 - 45 PSI at operating speed.

Directly beneath the oil pressure gage is the pump suction gage. This gage is connected to the suction side of the pump. You see that the gage reads from -30 to +15. When the gage reads on the minus side,this means that the pump is sucking fuel from a source. Just as you suck something thru a straw. When the gage reads on the plus side it means that fuel is being pumped or gravity fed into the pump instead of being sucked by the pump.

If the suction gage is registering either on the plus or minus side and suddenly drops to 0, this means that something has happened to your fuel source.

To the left of the suction gage is the pump pressure gage. This gage is connected to the discharge side of the pump. It indicates pump discharge pressure for 0 - 200 pounds per square inch.

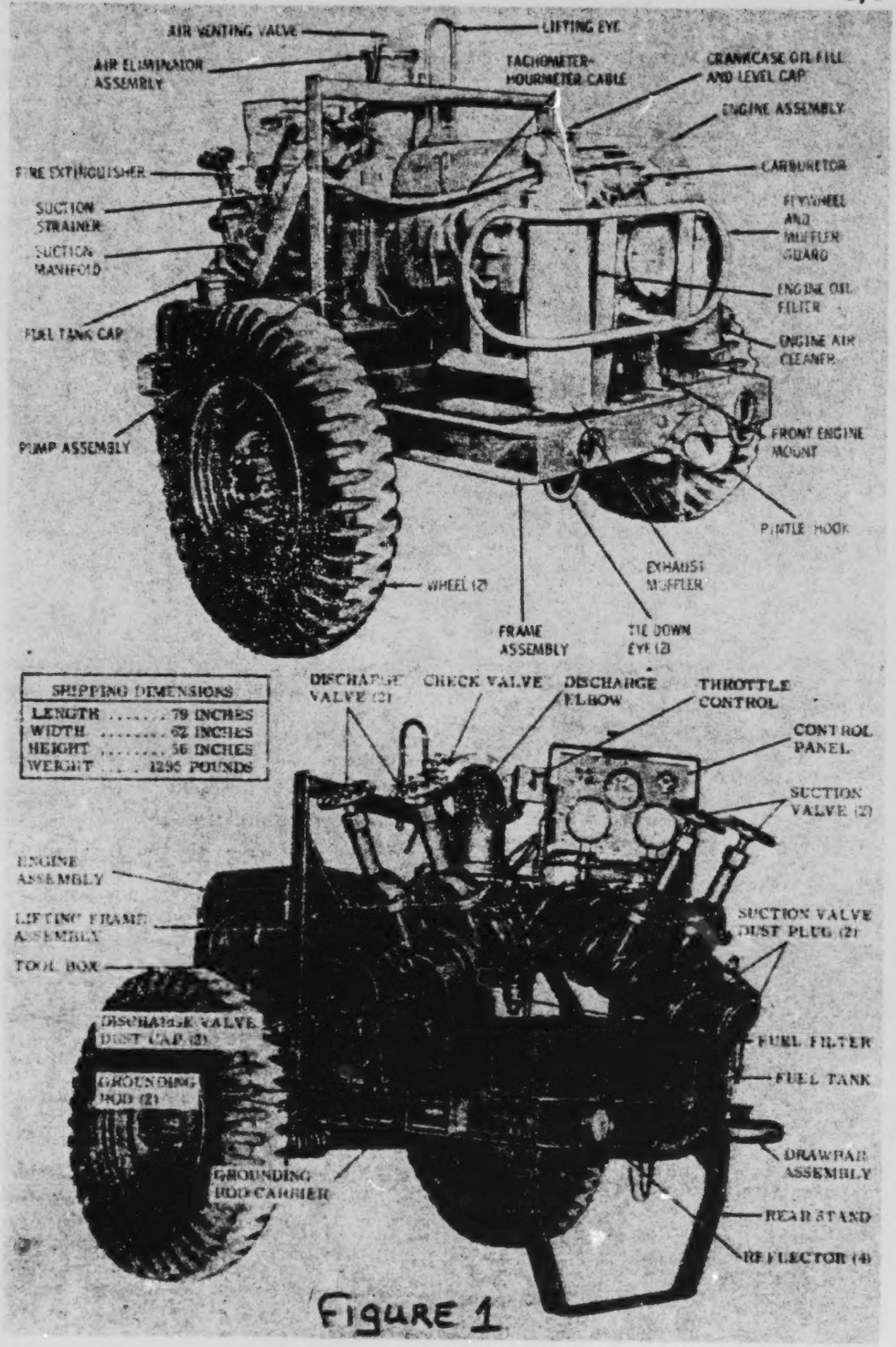
Above the pump pressure gage are the starting switches. When you start the pump, place left hand switch to start and press down on right handswitch to start the engine. After pump starts and is running, move left hand switch to run. When you want to stop the pump, move left hand switch to stop. Got it? If not, don't worry, we'll talk about this more in the next lesson.

In the center of this panel is the tachometer-hourmeter. The needle points to engine RPM's. 700-800 RPM's is the range the engine should idle at. 3200-3600 RPM is the speed you should run the engine in a pumping operation. The hourmeter is the series of numbers running from left to right. When filling out the DA 2400 you get your hourly readings from the hourmeter, because this meter registers every hour/minute the 350 GPM pump assembly runs.

To the left of the control panel is the throttle control. This handle should be pushed in for idle and pulled out to increase engine speed RPM's. After proper RPM has been reached by pulling out the handle, it can be set at that speed by turning the handle clockwise.

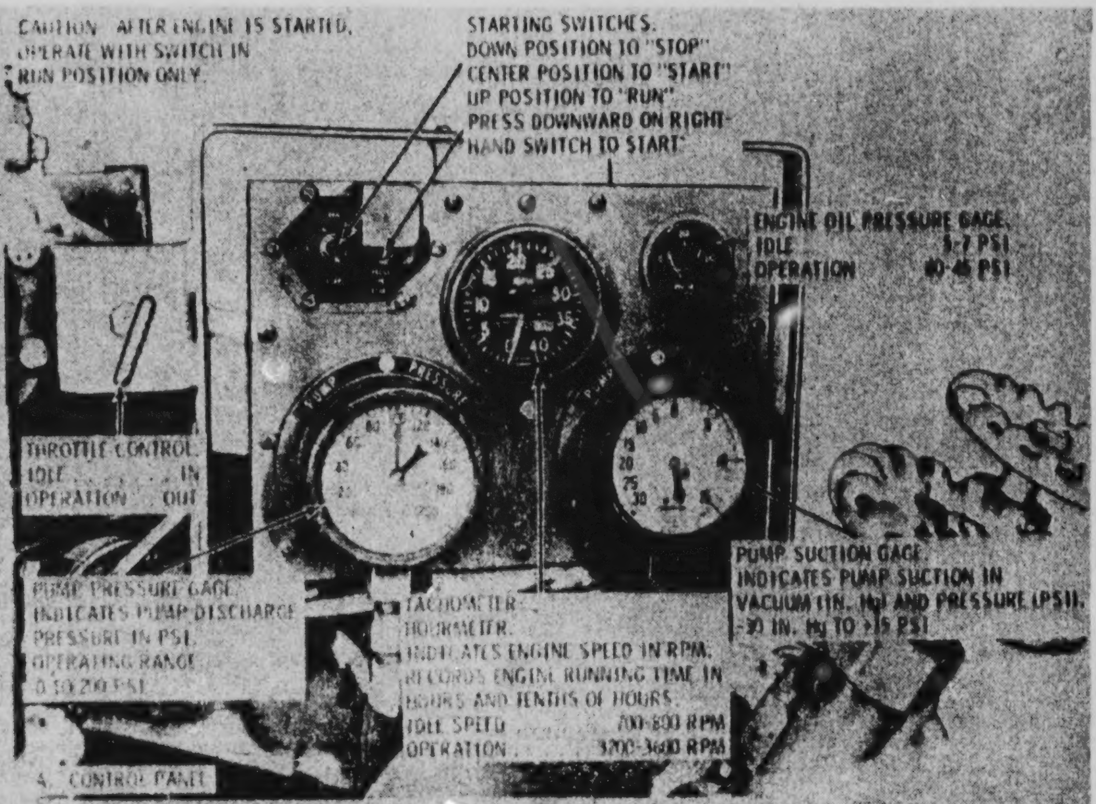
Another control even though it's not on the control panel is the fuel source selector valve directly above the sedimentation bowl. When the arrow on the handle is pointing down, fuel is being supplied by the fuel tank. When the arrow points up, an external fuel supply can be used. When the arrow points either left or right, fuel is shut off to the engine. Operate this valve and see what I'm talking about.

This concludes this portion of your lesson. If you don't understand the function or operation of all the components on the 350 GPM control panel, replay this portion of the tape and consult Figure 2 in your lesson booklet. If you have no questions, turn to Part III in your lesson booklet and follow the directions given in that section.


AIR VENTING VALVE
LIFTING EYE
AIR ELIMINATOR ASSEMBLY
TACHOMETER-HOURMETER CABLE
CRANKCASE OIL FILL AND LEVEL CAP
ENGINE ASSEMBLY
FIRE EXTINGUISHER
CARBURETOR
SUCTION STRAINER
FLYWHEEL AND MUFFLER GUARD
SUCTION MANIFOLD
ENGINE OIL FILTER
FUEL TANK CAP
ENGINE AIR CLEANER
PUMP ASSEMBLY
FRONT ENGINE MOUNT
PINTLE HOOK
EXHAUST MUFFLER
WHEEL (2)
FRAME ASSEMBLY
TIE DOWN EYE (2)
DISCHARGE VALVE (2)
CHECK VALVE
DISCHARGE ELBOW
THROTTLE CONTROL
CONTROL PANEL
SUCTION VALVE (2)
ENGINE ASSEMBLY
LIFTING FRAME ASSEMBLY
SUCTION VALVE DUST PLUG (2)
TOOL BOX
DISCHARGE VALVE DUST CAP (2)
FUEL FILTER
GROUNDING ROD (2)
FUEL TANK
DRAWBAR ASSEMBLY
GROUNDING ROD CARRIER
REAR STAND
REFLECTOR (4)

SHIPPING DIMENSIONS	
LENGTH	79 INCHES
WIDTH	62 INCHES
HEIGHT	56 INCHES
WEIGHT	1295 POUNDS

Figure 1


CAUTION AFTER ENGINE IS STARTED, OPERATE WITH SWITCH IN RUN POSITION ONLY.
STARTING SWITCHES. DOWN POSITION TO "STOP" CENTER POSITION TO "START" UP POSITION TO "RUN" PRESS DOWNWARD ON RIGHT-HAND SWITCH TO START.
ENGINE OIL PRESSURE GAGE. IDLE 5-7 PSI OPERATION 40-45 PSI
THROTTLE CONTROL. IDLE IN OPERATION OUT
PUMP PRESSURE GAGE. INDICATES PUMP DISCHARGE PRESSURE IN PSI. OPERATING RANGE 0 TO 200 PSI.
TACHOMETER-HOURMETER. INDICATES ENGINE SPEED IN RPM. RECORDS ENGINE RUNNING TIME IN HOURS AND TENTHS OF HOURS. IDLE SPEED 700-800 RPM OPERATION 3200-3600 RPM
PUMP SUCTION GAGE. INDICATES PUMP SUCTION IN VACUUM (IN. Hg) AND PRESSURE (PSI). -30 IN. Hg TO +15 PSI
PUMP PRESSURE

A. CONTROL PANEL

Figure 2

PART III

This portion of the lesson will teach you the operator's maintenance checks you are required to make before you can operate the 350 GPM pump. Pay close attention because you will be tested on operational maintenance checks.

Here is a list of operational maintenance checks, the number in the left hand column identifies a component on the pump. To the right of this number is the name of that component and the operational check you are required to perform. Some of these components aren't numbered because you have either already learned them or they're real easy to identify.

LOCATE THESE COMPONENTS WITH THIS LIST AND PERFORM THE OPERATIONAL MAINTENANCE CALLED FOR.

If you have any trouble with any part of this lesson please feel free to call on the instructor.

1. ENGINE OIL FILTER - Inspect for leaks.

3. CRANKCASE FILL AND LEVEL CAP - Check for proper crankcase oil level.

4. SUCTION STRAINER - Inspect for leaks, and tight fittings and once a week you take it apart and clean out dirt, and sediment.

5. FUEL TANK - Check fuel level (2/3 full) and clean strainer if needed.

7. TOOL BOX - Inspect for loose mounting.

8. BATTERY - Tighten loose cables and mountings, and make sure it has the proper level of electrolyte (water).

9. AIR CLEANER - Check red indicator inside glass housing -- if it's up or showing, push button, if red still shows -- check the filter elements and replace.

VALVES - Inspect for proper operation, leaks, and tight mounting.
CONTROLS AND INSTRUMENTS - Inspect for tight mounting, damage, and secure connections.
FUEL STRAINER - Inspect for tight fittings, leaks, cracked bowl and drain dirt and water if present.

FINISHED??? Make sure you know the name and can perform operator's maintenance on each component on the list. When you feel that you know the material, ask your instructor for further instructions.

313

PART IV

This portion of your lesson deals with actual operation of the 350 GPM pump. Read the following list of operating procedures carefully. After you have read the list, follow the exact directions given, DO NOT JUMP AHEAD.

Remember you are the boss in this operation, the machine will do exactly what you make it do.

-------------------------- SAFETY FIRST ------------------------------

To bring the pump on line follow the steps below:

1. Perform operator's maintenance and fill out TAMMS forms.
2. Ground the pump and place fire extinguishers.
3. Hook up hoses to pump ports.
4. Open suction valve.
5. Pull choke - if engine is cold.
6. Push in throttle to idle position.
7. Press left switch on control panel to start.
8. Press right switch on control panel to start.
9. When pump starts push left switch to run.
10. After pump is running, push in choke.
11. Warm up pump for five to ten minutes.
12. Open discharge valve.
13. Open air vent valve.
14. Pull throttle and lock it @ 2500 RPM.

The pump is now operating "on line."

320

To shut down the pump, do the steps below:

1. Push in throttle to idle position.
2. Close air vent valve.
3. Close discharge valve.
4. Idle pump for 5-10 min to cool it off.
5. Close suction valve.
6. Press left switch to stop.
7. Disconnect hoses.
8. Disconnect ground
9. Perform operator's maintenance and fill out TAMMS forms.

You have now learned how to operate the 350 GPM pump. Practice the steps above and learn them well. When you think you know them, contact your instructor for your test on the 350 GPM.

INTRODUCTION

Have you ever driven an automobile that hopped and jumped and ran very poorly and found out that the reason was dirt and water in the gasoline. Sometimes this contaminated gasoline even causes the engine to stall. Picture in your mind what would happen if Avgas or JP-4 had water in it. What would happen if the airplane stalled?

To prevent airplanes from being fueled with fuel contaminated by water and dirt the Army uses a filter separator. This piece of equipment removes water and dirt from the fuel.

In this lesson you will learn the 350 GPM filter/separator. This filter/separator will remove water from fuel as the fuel is being pumped thru it at the rate of 350 gallons per minute.

OBJECTIVE

You will be able to (1) Perform operational safety and maintenance checks on the 350 GPM filter/separator. (2) Operate and perform basic trouble shooting on the 350 GPM filter/separator.

HOW TO USE THIS PROGRAM

Read each section carefully and follow all directions. If at any time you have any questions, call on the instructor nearby.

Part I is a general description of key components and their functions.

Part II will teach you the operator's maintenance checks and you will be required to perform and to operate the 350 GPM filter/separator.

Part III is the examination which will deal with operational maintenance and operation of the 350 GPM filter/ separator.

PART I

This is the 350 GPM Filter/Separator. This portion of your program will teach you it's key components of the 350 GPM Filter/Separator and how they work so that you can operate it effectively. Look for the 4" female port. This is the inlet port. The 4" male port is the discharge port. Fuel enters the inlet port possibly containing dirt and water. When it leaves the discharge port, all dirt and water have been removed.

Find the sight glass. This shows the liquid inside the filter/separator body. When there is water in the filter/separator you'll see it in the sight glass (See Fig 2).

Look at figure one and locate item #6. This is the water drain off valve. When the filter/separator is operating, this valve automatically drains off the water that has been removed from the fuel. Also when the sight glass shows a high water level, you can open this valve to drain off the water.

Item #5 is the bottom drain off. When you want to drain the entire filter/separator open this valve.

After the filter separator has been operated for a while, the filter elements inside get dirty and clogged up with dirt and trash. When they get too dirty to work properly, the pressure differential indicator (item 7) will pop up. When this happens you have to change the filter elements.

Look on the top of the filter/separator and locate item #1. This is the air eliminator. This works similar to the air vent valve on the 350 GPM pump. When you begin operation, open this valve. After all air is bled off and fuel starts coming out this valve, close it.

Look at the filter canister. Inside this canister is a filter element. These components do the actual work of removing sediment and water from the fuel. There are 18 of these canisters/elements in the 350 GPM filter/separator.

When you think you can identify and explain how each of these components works, go on to Part II. If you don't know all the information above, review it and call your instructor for help.

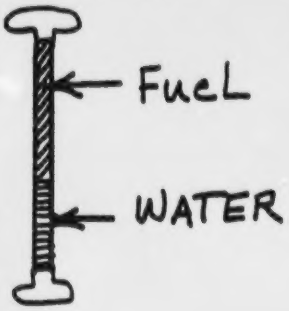
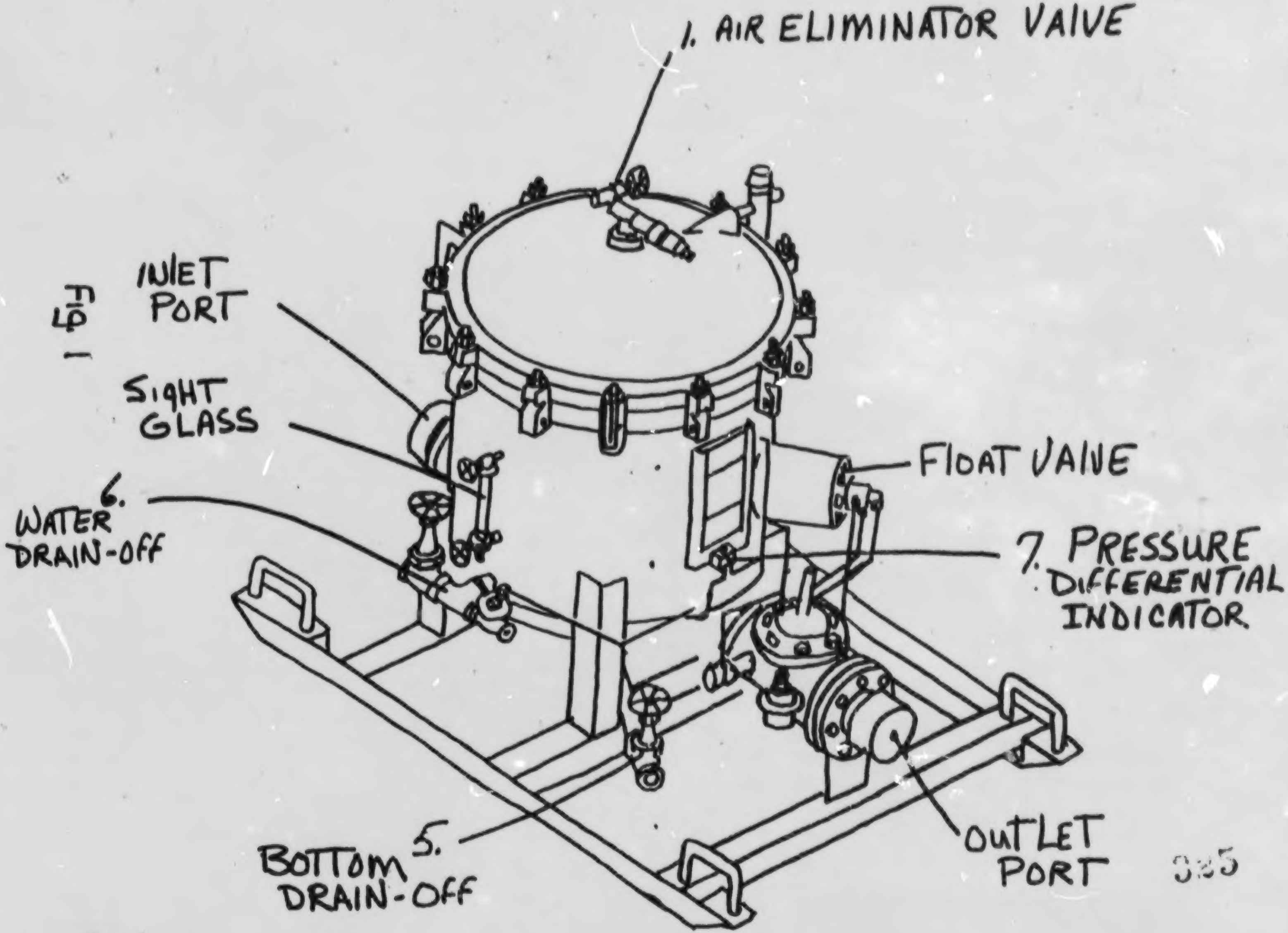


Fig 2


1. AIR ELIMINATOR VALVE
INLET PORT
SIGHT GLASS
6. WATER DRAIN-OFF
FLOAT VALVE
7. PRESSURE DIFFERENTIAL INDICATOR
OUTLET PORT
5. BOTTOM DRAIN-OFF
325

PART II

Now that you know all the key components of the 350 GPM filter separator we'll see how to operate it. Most of the operating procedures on this filter separator are really operator's maintenance. So pay close attention to the steps listed below. Just as you did with the 350 GPM operating steps, do each one of the steps in this list from beginning to end --- don't skip any.

When you finish the list and know each one, you will know all you need in order to operate and maintain the 350 GPM filter separator.

1. Place filter separator on level ground.
2. Ground the unit and position fire extinguisher.
3. Raise the cover and check to see if the elements are installed properly, then close the cover.
4. Connect hoses to the inlet and outlet ports.
5. Check the whole unit for leaks and cracks or damage.
6. Start the pump.
7. Open manual vent valve till fuel appears then close the valve.
8. Open drain valve pet cock on liquid level gage (sight glass).
9. Open gage valves to allow fuel to flow thru the filter separator.
10. After fuel is flowing thru the filter separator, check for leaks.
11. Check pressure differential at least every two (2) hours.
12. If pressure differential button is up or leaks occur, shut down the pumping operation at once and correct the problem.
13. After operation, close valves to isolate the filter separator from fuel flow.
14. Open manual drain valve until fuel appears and close.
15. Check for cracks and leaks.
16. Close all valves on the filter separator.

319

APPENDIX I

The "new" or latest 350 GPM filter separator used by the Army today workds basically the same as the one you just learned in Part I of this program. Just as the "old" one it removes dirt and water from the fuel.

Lets take a look at the key components of this unit. Refer to figure 2 for location of the components.

Item 1 is the air eliminator valve - you operate it the same as the filter/separator in part 1 of this program.

Item 2 is the 4" inlet port.

Item 3 is the 4" discharge or outlet port.

Item 4 is the water drain off valve. This valve is hand operated. When the sight glass (item 5) shows water is present in the filter/separator sump, you open the valve and drain the water out. Open the drain and let the liquid out, shut the valve when you see fuel appear.

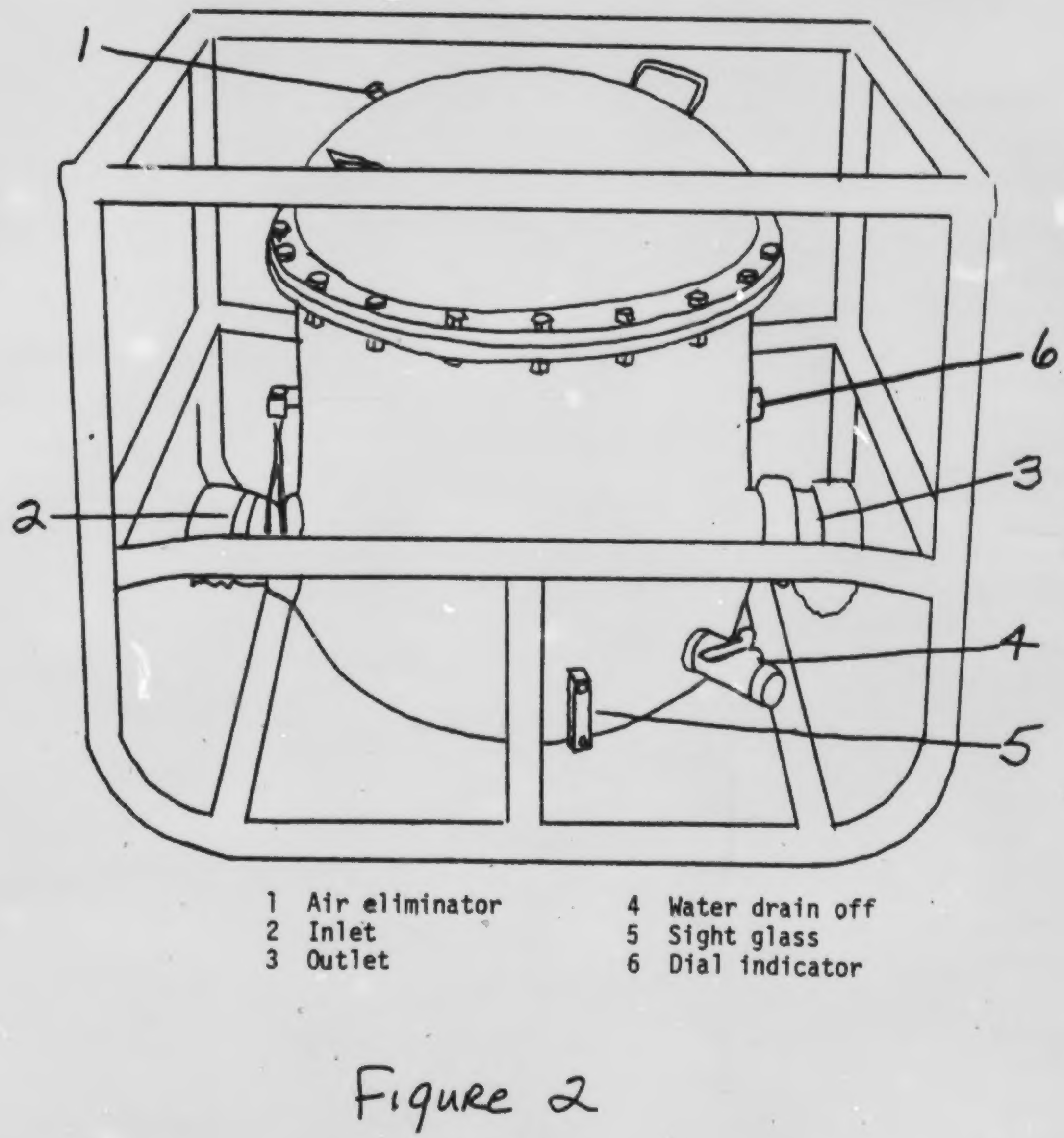
Item 5 is the sight glass. There is a small ball that floats inside this glass. The ball floats on the water contained in the filter separator sump. When the ball is floating, you know you have water to drain off.

Item 6 is a dial indicator. This indicator takes the place of the old pressure differential indicator. This gauge indicates the cleanliness of the filter elements. When the needle moves into the red while you're operating, continue using the filter separator until the end of tnat operation then shut down and clean/replace the filter elements.

Well, thats it as far as key components. Not that tough was it?

327

"NEW"
350GPM Filter/Separator



1 Air eliminator
2 Inlet
3 Outlet
4 Water drain off
5 Sight glass
6 Dial indicator

Figure 2

Lets go over the operation and maintenance procedures you will be required to perform when you operate this model filter/separator. Pay attention and learn the steps listed below. Do each one of the steps from beginning to end -- don't skip any.

1. Place filter separator on level ground.

2. Ground the unit and position fire extinguisher.

3. Connect hoses to the inlet and outlet.

4. Check the whole unit for leaks, cracks or damage.

5. Start the pump.

6. Open the water drain off valve if the sight glass shows fuel in the filter/separator sump.

7. Open gate valves to allow fuel to flow thru the filter/separator.

8. Open manual vent valve until fuel appears then close the valve.

9. After fuel is flowing thru the filter/seapartor, check for leaks.

10. Check the dial indicator at least every two hours.

11. If dial indicator goes into the red, replace filter elements at the end of the operation.

12. After operation, close valves to isolate the filter separator from fuel flow.

13. Open manual water dr[illegible] off until fuel appears.

14. Check for cracks and leaks.

15. Close all valves on the filter separator.

You have not completed the operation and maintenance of both models of 350 GPM filter separator the Army has in use today. Review this program until you think you know it. If you have any questions, ask the instructor for help. When you think you know all the operations and maintenance proceudre, ask the instructor for the test.

FUEL SYSTEM SUPPLY POINT
(FSSP)
OPERATION AND LAYOUT

PROPONENT DEPARTMENT: Petroleum & Field Services

November 1977

This supersedes QMS 300.666 H-1 dated May 1977.

FSSP LAYOUT

INTRODUCTION

You have probably seen movies and television showing your Army in action. Have you ever wondered how all the tanks, jeeps, trucks, airplanes, generators, and other equipment on the front lines managed to stay at the front and operating? Imagine, if you can, how much gasoline, diesel, and aircraft fuel are needed for battlefield operations.

In order to meet the bulk fuel needs of today's fast moving combat division, the Army developed a system which can be quickly assembled or disassembled and also receive, store, and issue large quantities of bulk fuel.

OBJECTIVE

You will be required to lay-out and set-up a fuel system supply point to:

1. Store 30,000 gallons of fuel.
2. Receive fuel from M131 tankers at two points.
3. Bottom load the M131 and M49 tankers from separate points.
4. Dispense fuel from 1" nozzles from three separate points.
5. Transfer fuel from tank to tank within the system.
6. Receive and issue simultaneously.

HOW TO USE THIS PROGRAM

All directions for you to follow are in the program. Read each page carefully, and perform whatever action you are told to do. If you have any questions, your instructor will help you. Work through the program at your own pace.

GOOD LUCK!

PART I

The beautiful part about the Fuel System Supply Point (FSSP) is that it is so versatile. We could go into detail and explain five ways to lay-out the system, and after you are familiar with the system, you could design five different lay-outs and someone else could design five more.

There are several things to remember when laying out your FSSP.

1. Make sure that traffic in and around your area is not congested. Vehicles should be able to come and go easily without getting into traffic jams.

2. Never lay-out a FSSP in a low confined area. Remember that fumes are heavier than air. Select an area where air moves freely and can carry away fumes safely.

3. Insure that there is a good drainage system. Heavy vehicles tend to tear up the ground quite a bit. Heavy rain would cause a mud bath and a lot of stuck vehicles unless there is good drainage.

4. Take advantage of natural cover and concealment. Never cut trees and bushes unless they present a fire or safety hazard.

5. Take advantage of level ground. Collapsible tanks have a tendency to slip downhill. If the tanks cannot lie on perfectly flat ground, you might even have to tie them down. Also, the filter separator does not work properly unless it is level.

6. Insure fire and safety rules are observed. Check fire extinguishers, have sand and shovels available for spills, post "No Smoking" signs, construct fire walls (time permitting), and observe all your other fire and safety rules.

ANSWER THE FOLLOWING QUESTIONS:

1. What do the letters FSSP mean? ______________________________

____

2. When laying out a collapsible tank in the FSSP, why is it necessary to make sure it is on flat ground? ______________________________

____

3. Why was the FSSP developed? ______________________________

____

4. When would you cut and remove trees or brush from your FSSP area?

____

Turn the page, and check your answers.

326

ANSWERS TO QUESTIONS ON PAGE 3:

1. Fuel System Supply Point

2. Collapsible tanks have a tendency to creep or move downhill when laid on a slope.

3. To provide bulk fuel for combat units close to the front.

4. When they present a fire or safety hazard.

If your answers do not agree with those above, review your work before going to the next page. If you have any questions, see your instructor.

NOTE: At this time you should see the TV film on the FSSP.

334

As we previously stated, there are many different layouts for the FSSP. What actually determines the exact layout will be terrain features and mission requirements.

Remove pages 16 & 17 from your program and lay them beside your program so you can easily follow your next steps. Don't lose these pages because you will need them later on.

1. Look on page 16. You see here a basic layout for a FSSP very similar to the FSSP's "Wet System" at the Petroleum Training Facility. (Later in Part II of this program, you will go see this system.)

2. Note the large squares with the large numbers--these represent the six 10,000 gallon collapsible tanks in a standard FSSP. They are numbered one through six here for easy identification.

3. At the top of page 16 you have a receiving pump shown as a small square. Fuel is received into your system through this pump.

4. From this pump, the fuel goes to the filter separator marked "A".

5. From the filter separator marked "A", it enters the striped line. NOTE: All of the fuel lines connecting the pumps, tanks, and filter separator are four-inch flexible, wire-stiffened hoses, twelve feet long. They are "Quick Coupled" together.

6. The striped line on page 16 represents the receiving line, or in other words, the line which carries fuel into the tanks.

7. The clear line is the discharge line--sometimes called the suction line because it carries fuel out of the tanks.

8. The clear line takes fuel from the tanks to the delivery pump at the bottom on page 16.

9. From the delivery pump, the fuel can go to the solid black line to your filter separator marked "B" and on to the dispensing points or back to another tank, depending on what valves you open.

You have been looking at the general layout of this system on page 16. Now, let's take a look at the components in it.

1. Notice that on the lines there are circles with an "X" (⊗). These marks represent valve assemblies. They are marked with small numbers one through thirteen.

2. Look at valve assembly "G" on page 17. This valve assembly is located at the points marked 2-4-6-8-10 and 12 on page 16.

3. Look at valve assembly "A" on page 17. This assembly is located at points 1-3-5-7-9 and 11 on page 16.

4. Find valve 13 on page 16. This is assembly "B" on page 17.

5. Numbers 14 and 15 on page [illegible] are "Y" fittings. They are shown respectively on page 17 as assemblies "J" and "H".

OPERATION OF THE FSSP

When combat forces are on the move they need fuel.. Since it is not always possible to build a pipeline as fast as units move, the Army uses the fuel system supply point (FSSP) to supply fuel to these trucks. The fuel system supply point is used to receive fuel from trucks, railway cars, aircraft, tankers and pipelines. The fuel is then stored and issued to using units in the field.

On page 16 of this program is a typical layout of the FSSP. You see it has 6 collapsible tanks. These tanks hold 10,000 gallons each. 2400 feet of suction and discharge hose along with fittings and nozzles, two 350 GPM pumps and filter separators complete the system.

Pay close attention to this lesson and you will learn how to operate the FSSP in receiving transfer and dispensing operations.

OPERATION

The first thing to do is close all valves in the FSSP. Then open only those valves that are needed for the operation. For example, if a tank truck is discharging fuel into the receiving point and you want to put it in tank #3, let's trace the flow and see which valves to open (look at system). Follow the flow thru the receiving pump and filter separator and down the "inside line" (striped). Open valve #6. If all other valves have been closed, the only place the fuel can go is thru valves #6 and into tank #3. Got it? Always open the valves on the suction side of the pump first but don't pump against a closed valve.* NOTE: #14 and #15 are "Y" fittings, not valves.

SITUATION 1

Try receiving fuel and putting it in tank #5. What valve would you open? Close? Turn to page 5 of this program and see if you are correct.

Next, let's try taking fuel out of Tank #6 and pumping it out to a dispensing point.

Notice that there is a delivery pump - we want to suck fuel out of tank #6 and pump it out the dispensing point using this pump.

First close all valves. Next follow the suction (outside) line back to tank six from the suction side of the delivery pump. You see that valves #11 would have to be opened to get fuel from tank #6 into the suction side of the pump. Got it: Close all valves.

SITUATION 2

Try taking fuel out of tank #1 and pumping it out to a dispensing point.

See page 10 of your program to check on your answer.

*During warm up and cool down the pump is idled with the suction valve open. When ready to pump, open the discharge valve and then increase the RPM.

Now that you know how to receive fuel and dispense fuel with the FSSP, let's see how to transfer fuel from one tank to another within the system.

Let's try transferring fuel from tank 1 to tank 4. First close all valves. Next open valve 1 - this will get fuel out of tank 1 and into the suction side of the delivery pump. Now follow the fuel out of the discharge port. Open valve #13, this will put fuel into the inside line (striped). Open valve #8. This will let fuel flow out of the inside line and into tank #4. Review this exercise until you feel you understand all the steps involved. If you have any questions - ask your instructor for help. When you feel you know how to transfer fuel from one tank to another within the sytem, try the next exercise.

SITUATION 3

Transfer fuel from tank 6 to tank 2. Check on page 10 of this program for the solution.

REMEMBER!!! - Never pump against a closed valve - before bringing a pump on-line make sure the fuel has somewhere to go!

Review all of the operations you have learned in this program until you can perform each of them.

SITUATION 1 SOLUTION: You should have opened valve #10. All other valves should be closed. If you didn't open and close valves in this manner go back and see that you understand why they are.

SITUATION 2 SOLUTION: You should have opened valve #1. All other valves should be closed. If you didn't open valve #1 go back in the program and find out why is should be opened.

SITUATION 3 SOLUTION: You should have opened valves #4 and 11. All other valves should be closed. Make sure you know why the above valves should be opened and closad by reviewing your program.

PART II

Having familiarized yourself with the basic operation and layout of the FSSP, you are ready for the practical exercise which begins with a walk-thru of the wet system. At this time, see your training manager and ask for the PE on the FSSP.

You should now be standing beside the receiving pump in the FSSP "Wet System" in the PTF. There is only one receiving point here. Walk through the system, noting the different types of assemblies, and where and how they are used. Follow the steps outlined below.

1. At the end of the receiving line, you see a 3" gate valve. It is similar to assembly "E" on page 17, except that it is 3" inlet and 3" outlet.

NOTE: At this point, a 3" Quick Opening Ball Valve should be used, but they are in short supply. This valve will be replaced when the valves arrive.

2. Follow your 3" line back to a special assembly. This assembly has three 3" female ports and one 4" male port. You can see where two additional receiving lines could be attached.

3. Follow down the 4" line to your next assembly. This is assembly "C" on page 17. At this point, you can see that we have a bypass line installed with a gate valve. See how you could bypass your pump, using the truck's pump to off-load its fuel. This is good to remember should your pump ever get deadlined or be needed elsewhere.

4. Follow on down the line into the FSSP until you come to an assembly "B" (or 4" gate valve). Stand beside this valve and look at the way the hose lines are laid out. The line you have been walking is the receiving line. It forms the elongated "U" of the inside line.

5. Note that all of the tanks are connected to this receiving line with a "G" assembly.

6. While still at this spot, note the outside line. It lies along the firewall forming a large elongated "U" around your receiving line. This line is the suction line to the issue pump.

7. Note that all the tanks are connected to this line with assembly "A".

8. Proceed up the receiving line until you come to assembly "H". This is a "Y" type assembly. On two sides of this assembly there is a "B" assembly. These gate valves serve as blocking valves to cut down fuel loss if repairs are needed. Note that this "H" assembly is connected to the discharge side of the issue pump.

9. Note that the outside line is connected to the suction side of the issue pumping using as assembly "C" and one assembly "B". Again, the "B" assembly used as a block valve. At this point, you could use an assembly "J" instead of the "C". Remember this; because when you lay-out the system, you will have to use the "J" assembly.

10. Go to the issue pump & follow the discharge line to the filter separator.

11. See how the three "B" assemblies are used so that fuel can be pumped through the unit or bypass the unit. There is a "B" assembly on either side of the filter separator and one in the bypass line.

12. Continue down the line to a "G" assembly. At this point you connect to the issue points. To your right you see two 3" bottom loading points. The farthest point has the 3" Quick Opening Ball Valve and the nearest is a quick couple fitting only.

NOTE: Take a few minutes to study how these points are connected to the main four inch lines; then, return to this point.

13. Turn left and follow the issue line down to the next point. Here again we have a bottom loading point with a 3" quick coupling end. Notice how the "C" and "D" assemblies are used to make this connection.

14. Follow on down the line, past the next point, until you come to a "D" assembly in the main line. This reduces your line from 4" to 3".

15. Follow on down the line to an "E" assembly. This reduces the 3" line to 2". Connected to this "E" assembly is assembly "F" and your 1" dispensing hose and nozzle.

16. Follow the line to its end and you will see two more 1" dispensing points connected the same as the first.

You have now walked through the complete system. Compare this system to the basic layout on page 16.

By the way, see the dirt walls around each 10,000 gallon collapsible tank? These are called firewalls. We use them to protect the tanks from ground fire and in case the tank springs a leak, the fuel won't run everywhere. The firewall must be large enough to hold 100% of the fuel in the tank and still have 1 foot of "free board" or wall above the fuel surface if the tank ruptured.

Also, see the display beside the 350 GPM dispensing pump. If any of your collapsible tanks spring a leak, you'll have to use one of the emergency repair devices shown. Take a close look at them and if you have any questions, ask your instructor for help.

When you feel confident that you understand how the system is assembled report to the instructor in the FSSP dry system for Part III.

PART III

Your instructor will place you in a group of students at the same stage of this course as you are. The instructor will assemble your group at the starting point. This will be a practice exercise; so when the instructor gives you the go ahead, read your instructions carefully, and follow directions closely. Upon completion of this exercise, your group will be tested on laying out this system correctly without the aid of diagrams or text. It will be a timed exam in which you have a limited time in which to layout the FSSP.

1. In front of you there is a layout diagram of the FSSP that you are to construct. (You have a copy of the layout on page 15 of your program).

2. The three 10,000 gallon collapsible tanks, the 350 GPM pump, and the filter separator are already in place. DO NOT MOVE THEM.

3. Key points in the layout are designated as POINT #1, POINT #2, etc. Look near the bottom of the diagram and you'll see POINT #1. Now, look behind you, and you will see a stake with a sign marked POINT #1.

4. All the equipment you need from Point #1 through Point #4 is on Pad "A". From Point #4 through Point #10 is on Pad "B". The hard hose is stored in its rack.

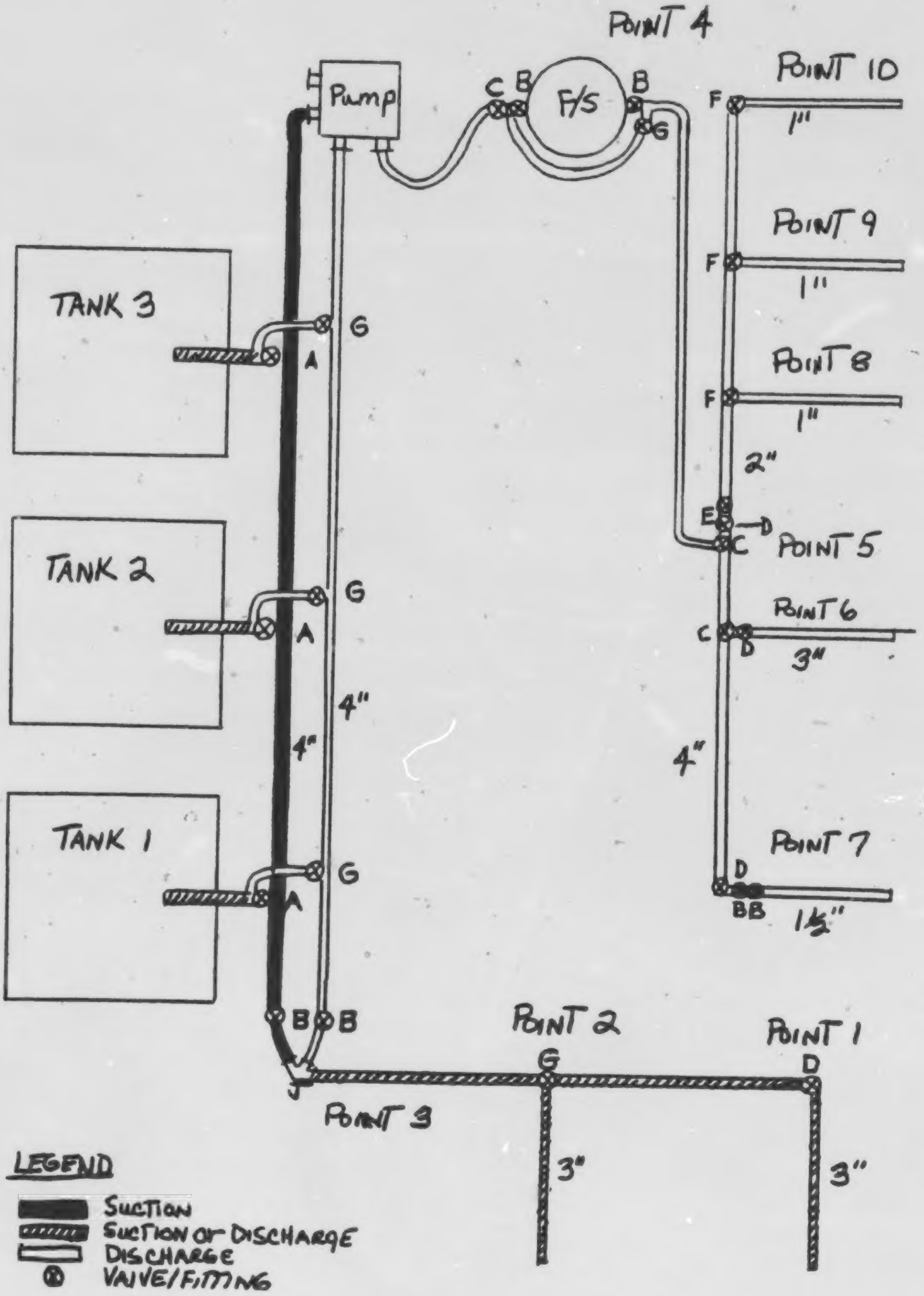
5. Before you begin construction, pay close attention where each piece is stored; because, after you complete the exercise, you will have to return all the pieces to their proper storage places.

6. Construct your layout now.

7. After completion of layout, ask your instructor to check your work.

8. In the examination, you will have to construct this layout from memory in a limited amount of time. If you and your group feel ready for the exam, replace all the equipment in its original storage point. You may practice again, if you feel it's necessary. Then advise your instructor you are ready for the exam.

NOTE: After the layout portion of the exam your instructor will supervise you in a wet system exercise and the other half of the examination.


POINT 4
Pump
C
B
F/S
B
G
F
POINT 10
1"
POINT 9
F
1"
POINT 8
F
1"
2"
E
D
C
POINT 5
POINT 6
C
D
3"
4"
POINT 7
D
BB
1½"
TANK 3
G
A
TANK 2
G
A
4"
4"
TANK 1
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3"
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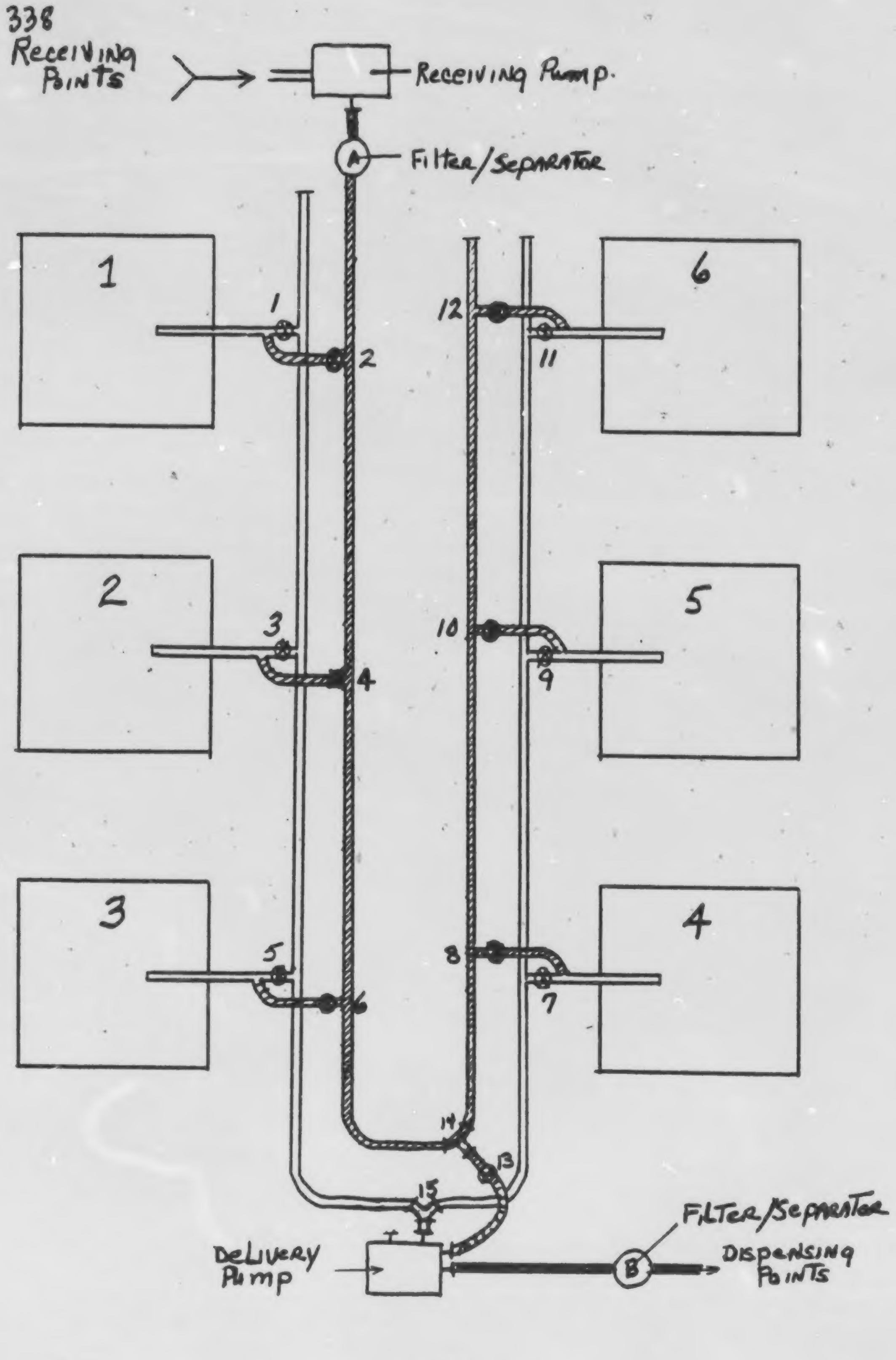
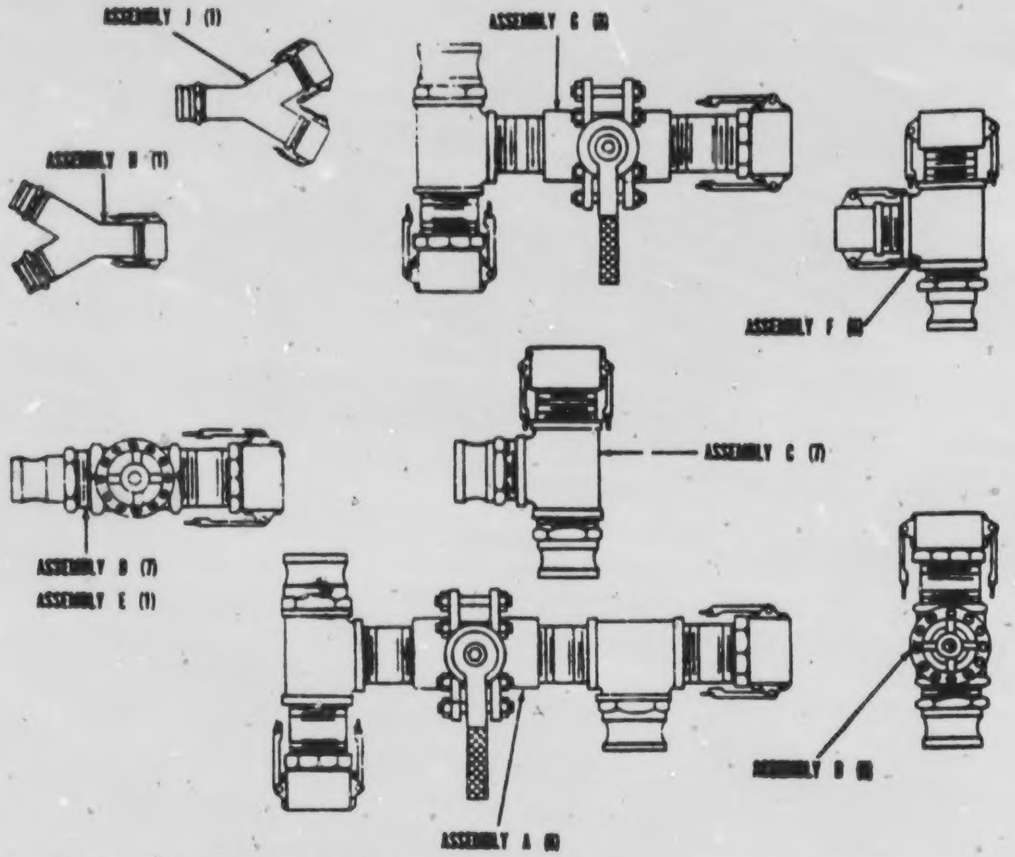
LEGEND
SUCTION
SUCTION or DISCHARGE
DISCHARGE
VALVE/FITTING


Receiving Points
Receiving Pump.
A
Filter/Separator
Filter/Separator
B
Delivery Pump
Dispensing Points


ASSEMBLY J (1)
ASSEMBLY G (6)
ASSEMBLY H (1)
ASSEMBLY F (6)
ASSEMBLY C (7)
ASSEMBLY D (7)
ASSEMBLY E (1)
ASSEMBLY B (9)
ASSEMBLY A (6)

Assembly A: 4-inch butterfly valve, in tank manifolds (6)
Assembly B: 4-inch gate valve (9)
Assembly C. 4-inch T-coupling (7)
Assembly D: 4-inch gate valve, 4 inch inlet to 3-inch outlet (7)
Assembly E: 3-inch gate valve, 3-inch inlet to 2-inch outlet (1)
Assembly F: T-coupling, 2-inch run to 1-inch lateral (6)
Assembly G: 4-inch butterfly valve, in tank manifolds (6)
Assembly H: 4-inch Y-coupling (1)
Assembly J: 4-inch Y-coupling (1)

Figure 2. Valve and fitting assemblies in the fuel system.

QMS 300.439 H-1 340
Part I

M-131 5,000 GALLON
SEMI TRAILER

PROPONENT DEPARTMENT: Petroleum and Field Services

April 1978

This handout supersedes QMS 300.439 H-1 Pt I dated April 1977

INSTRUCTIONS TO STUDENT

NOTICE

Read all the instructions carefully and follow your text closely. Do not move on to the next step until you understand the step you are on. If you run into problems consult your instructor. Proceed at your own pace.

GOOD LUCK!!

INTRODUCTION

In this lesson you will learn how to safely operate the M-131, 5,000 gallon semi-trailer. This semi-trailer is used throughout the Army and there is no doubt you will be working with this tanker when you leave the school.

The most common models used in the Army today are the M131A4C and M131A5C. There are only minor differences between each model: the M131A4C has four 1,250 gallon compartments and M131A5C has two 2,5000 gallon compartments.

These semi-trailers are designed to carry 5,000 gallons of fuel on hard surface roads or 3,300 gallons on rough terrain (off the road as in tactical situations). During this lesson you will only be working with the M131A5C, but if you can fully understand all you need to know about this tanker, you will find that it will be a snap to operate the other models. For additional information about M131 series semi-trailers, you can refer to TM 10-1113. It would be well to remember this TM because you will frequently use this book in the field after you leave school.

TURN THE PAGE

OBJECTIVES

As a result of the instructions in this lesson and when provided with a M131, 5,000 gallon semi-trailer, the student will be able to:

1. Perform operator's maintenance on the semi-trailer

2. Operate the manifold, auxilary pump and components of the semi-trailer to perform on-loading and off-loading operations observing all safety precautions.

PART I - Safety

You have already learned that safety is emphasized in every petroleum operation. Still safety cannot be preached enough. Every year there are people killed and seriously injured because someone forgot safety. Study the following list of safety precautions and remember these safety rules. There is very little danger when you follow the rules.

1. Make sure all equipment is bonded and grounded.
2. Rules prohibiting smoking must be established and strictly enforced. NO SMOKING signs must be prominently posted.
3. Fire fighting equipment must be operational and easy to get to.
4. Open flames, heating stoves, electric tools and any flame or spark producing equipment must be prohibited from the petroleum transfer area.
5. Spills should be avoided and cleaned up immediately should they occur.
6. Make sure there is adequate ventilation.
7. Tank vehicles should be at least 25 feet apart and drivers must be observant of safety precautions.
8. Practice good housekeeping by keeping rags, tools and debris out of the operating area.
9. Keep tractor and semi-trailer coupled so that it can be moved quickly in an emergency.
10. Do not wear synthetic clothes or shoes with metal cleats or nails.

11. Do not breathe fuel fumes. Stay upwind.

12. Perform frequent inspections of equipment and your area. Find trouble before it starts.

13. Never wear headgear over open hatches.

Now, take a blank piece of paper and without looking at this list, see if you can write 13 safety rules, then compare your list to the previous list.

Part II - Film and Display

During this phase of instruction you will see a film on tank vehicle operation and familiarize yourself with the manifold and pumping system of the M131A5C.

1. Watch the film on tank vehicle operations. NOTE: You are only concerned with the 5,000 gallon tanker in this lesson.

2. Move to the M131A5C training aid display. At this display you will learn how the fuel flows through the manifold and pumping system of the vehicle.

a. First look at the manifold, #1. The manifold is a hollow chamber used to route the flow of fuel in different directions.

b. The gravity discharge valve #2 allows fuel into or out of the manifold.

c. On the back side of the manifold you can see two pipes that go to the front and rear tanks. Check these pipes out and note where they connect to the manifold.

d. At either end of these pipes you have a valve. On the tank end of these pipes are the emergency dump valves #3. Follow the cable back from the emergency dump valves and you see they go to the dump valve levers, #4, just to the left of the manifold. Check this out. The other end of these two pipes are connected to the backside of the manifold. They are opened and closed by the compartment manifold valves #5 and #6, located on the front of the manifold. With what you have just learned, follow the flow of fuel to or from either compartment through the gravity discharge port, as indicated by the yellow lines on the display.

e. The pump cutoff valve, #7, is on the far right of the manifold. Just above it is the pump intake valve, #8. Follow the pipe behind each valve and you see that they join together just above and behind the right rear of the manifold. After these pipes join together into one pipe, the pipe runs to the suction side of the pump, #9. With what you have just learned, follow the flow of fuel from:

(1) The pump intake valve to the suction side of the pump, as indicated by the blue line on the display.

(2) From either compartment through the manifold to the suction side of the pump, as indicated by the red line on the display.

f. From the pump, #7, the fuel can flow two ways:

(1) First it can flow directly to the 3-inch discharge valve, #10, as indicated by the black line on the diagram.

(2) Second, it can flow to the filter separator, #11, as indicated by the green line on the display.

With what you have just learned follow the flow of fuel until you are satisfied that you understand the manifold system.

g. From the filter separator the fuel passes through the 3-way valve, #12, meter, #13, and is discharged through the 0-55 GPM dispensing hose, #14, or the 225 GPM dispensing hose, #15. NOTE: The cutoff valve to the appropriate hose and the 3-way valve would be open during this operation. This will be explained in detail later in the lesson. Follow the flow of fuel from the filter separator to the discharge hoses as indicated by the white line on the display.

3. Now that you understand how the fuel flows through the manifold and pumping system, study the following operations using the training aid display.

a. Bottom loading using the pump at the source of supply. Fuel is not filtered or metered when using this method.

(1) Connect a 3-inch hose from the source of supply to the gravity discharge valve.

(2) Open the gravity discharge valve, #2.

(3) Open one of the compartment manifold valves, #5 or #6.

(4) Open one of the emergency dump valve levers.

(5) Trace the flow of fuel from the gravity discharge valve to one of the compartments.

b. Bottom loading through the pump intake valve using the on-board pump. When using this method the fuel is not metered or filtered.

(1) Connect a 3-inch hose from the gravity discharge valve, #2 to the pump discharge valve, #10.

(2) Connect a 3-inch hose from the pump intake valve, #8, to the sourse of supply.

(3) Open one of the emergency dump valve levers, #4.

(4) Open one of the compartment manifold valves, #5 and #6.

(5) Open the gravity discharge valve, #2.

(6) Open the pump discharge valve, #10.

(7) Open the pump intake valve, #8.

(8) Open the pump cut-off valve.

(9) Trace the flow of fuel from the pump intake valve through the pump, through the pump discharge valve, through the gravity discharge valve, through the manifold and compartment manifold valve, through the emergency dump valve to the compartment.

c. Gravity discharging through the gravity discharge valve. The fuel is not filtered or metered when using this method.

(1) Connect a 3-inch hose from the gravity discharge valve, #2, to the receiving vehicle or recepticle.

(2) Open one of the emergency dump valve levers, #4.

(3) Open one of the compartment manifold valves, #5 or #6.

(4) Open the gravity discharge valve, #2.

(5) Trace the flow of fuel from one of the compartments through the manifold to the gravity discharge valve.

d. Unloading by pump, through the pump discharge valve. The fuel is not filtered or metered when using this method.

(1) Connect a 3-inch hose from the pump discharge valve, #10, to the receiving receptacle.

(2) Open one of the emergency dump valve levers, #4.

(3) Open one of the compartment manifold valves, #5 or #6.

(4) Open the pump cut off valve, #7.

(5) Trace the flow of fuel from one of the compartments through the manifold and pump to the pump discharge valve.

e. Discharging through the 225 GPM hose. The fuel is filtered and metered when using this method.

(1) Open the three way valve #12, by pulling the operating lever, #16, out.

(2) Open one of the emergency dump valve levers, #4.

(3) Open one of the compartment manifold valves, #5 or #6.

(4) Open the pump cut off valve, #7.

(5) Open the 225 GPM cut off valve, #17.

(6) Trace the flow of fuel from one of the compartments through the manifold, the pump, the filter separator, the 3-way valve, the meter and to the 225 GPM hose reel.

4. Review and study the five operations you have just conducted. If you have any problems contact an instructor for assistance. Proceed to Part III when you are satisfied that you know the five operations.

PART III
EQUIPMENT FAMILIARIZATION

During this phase of instruction you will familiarize yourself with the tank vehicle (M131A5C) and the equipment that comes with it. From here on all instruction/training will be conducted in the Petroleum Training Area (PTF). Your instructor will tell you which semi-trailer you will be working on.

1. Stand at the rear of the semi-trailer. Just on the left of the tank you will find a small compartment door. Open this door and inside you will find three 3-inch hoses and one gage stick. Remove the gage stick and look at it closely. One side is marked for compartment #1, the other side, compartment #2. Compartment #1 is the front tank and #2 is the rear tank. Replace the stick in side compartment after you are sure you can read it.

2. Now look at the ladder. The obvious purpose of this ladder is to climb up on the tanker. This ladder has another purpose. Notice that the ladder rails extend through the bumper and they are hollow. In the event of an overfill or spill on top of the tanker the fuel would flow through these ladder rails. Remember this and have drip pans available to put under the ladder during operations.

3. Climb the ladder and open the hatch cover on tank compartment #2 (rear). On the bottom of the cover you can see the pressure relief vent valve. Look inside the hatch. You will see a round disc on a metal rod. This disc is calibrated so that when the fuel level is at

the disc there is 2,5000 gallons of fuel in the compartment. (This, of course, is liquid gallons and for actual gallons a temperature conversion for volume correction is necessary.) Close the hatch cover and check compartment #1. You can see they are the same.

4. Secure the hatch covers and return to the ground facing the rear of the truck. Move around to the right side of the truck. Just in front of the wheels you will find a large compartment. It is called the curb-side cabinet. Open the door and you will find an engine and pump. There are several key points to remember.

a. The engine is in the left side of the cabinet.

b The engine oil dip-stick is on top of the engine near the back. Take it out, look at it and put it back.

c. The air filter for the carburetor is located near the left front of the engine. It operates the same as the filter on the 350 GPM pump you already studied. Note the reset button on top of it.

d. There is a manual choke control above the cauburetor on the left side of the engine. If you need to use this choke you will need an assistant since the starter button is on the other side of the trailer.

e. On the top left rear of the engine is the speed control lever.

f. In the right side of this cabinet you will find the pump, gasoline tank and battery.

g. Near the bottom of the pump on the right side you see a drain plug. Some units have a drain line with a pet cock valve attached for quick opening and closing. In sub-freezing weather it is necessary to drain off any accumulated water in the pump after each operation before it freezes.

h. At the top right of the cabinet is your gasoline tank. Check the volume of gasoline in the tank by removing the filler cap on top and looking inside. Under the gasoline tank is a glass sediment bowl to catch any water or sediment in the gasoline. Some of these bowls have a needle to let the fuel flow through it and some don't. If it has one it opens counter-clockwise and closes clockwise.

5. Close the curbside cabinet door. Just to the right of the cabinet you see the filter separator. At the bottom of the separator you see a manual water drain. The unit is also equipped with an automatic water drain. You can see the hole for that drain beside the manual water drain valve.

NOTE: When new trailers are shipped from the factory or the trailer is shipped long distances, say from California to Korea, the float inside the separator is wired down to prevent damage and a plug is installed in the drain opening. This situation has to be corrected before fuel is put in the tanker so remember this if you are ever in a unit and receive a new or replacement trailer. You'll learn more on the filter separator later but now continue your trip around the semi-trailer.

6. Just in front of the spare tire you see the landing gear. You will not be required to operate this equipment or be tested on it but you should be familiar with it. Sometimes this landing gear is referred to as "Dollys" but the correct name is landing gear. Just above the crank gear box is a foot pad. There is also a foot pad on the other side of the semi-trailer. These pads must be centered under the feet of the landing gear when the gear is lowered. The landing gear is lowered by

turning the crank clock-wise and raised by turning it counter-clockwise.

The operation of lowering the landing gear, disconnecting the tractor and pulling the tractor away is called "Spotting The Trailer" or sometimes - - "Dropping The Trailer". If you have to do this remember to do three things in this and only in this order.

a. Lower the landing gear until the feet are approximately 1/2 inch above the foot pads and centered. DO NOT LOWER THE FEET ALL THE WAY DOWN TIGHT.

b. Pull the fifth wheel release arm forward until it locks.

c. Remove air brake lines and electric inner vehicular cable.

You will not be required to "Spot The Trailer" during this lesson, but you should be familiar with the procedure.

TURN THE PAGE

Before continuing on in the program, answer the following questions.

1. What is the round disc in each compartment used for? ______________

____

____

2. If the fuel tanks were half filled, how could you determine how many gallons of fuel are in the tanks? ______________________

____

3. How many gallons of fuel can the trailer carry when used off the road?

____

4. What TM can you use to find answers to problems with the trailer?

____

5. Which rule of safety is most important? ______________

____

6. What is the diameter of the three hoses in the hose compartment?

____

7. Where is the engine battery located? ______________

____

8. Why is it important not to crank the landing gear down tight? _____

____

____

TURN THE PAGE

The answers for the preceding questions are:

1. The discs are used to indicate when the tank is full.

2. Use the gage stick, which is located in the hose compartment, to determine how many gallons are in a partially filled tank.

3. The off the road capacity for the M131A5C is 3,300 gallons.

4. Petroleum Tank Vehicle Operations are covered in TM 10-1113.

5. No one safety rule is more important than another. Breaking any safety rule could result in disaster.

6. The delivery hoses are three inches in diameter quick couple hoses.

7. The engine battery is located in the right side of the curb-side cabinet.

8. This was a tricky question since the answer isn't in the lesson or the TM. The answer is this: the semi-trailer when loaded is quite heavy. Leaving about 1/2-inch of drop space under the landing gear insures that the truck will lift most of the weight off the landing gear when it is hooked up again. The trailer doen't actually drop this half inch since it slides down on the skid plate. The trailer will sometimes settle a little so more than a half inch drop space could result in difficulty in "hooking up". Remember the crank is used to raise and lower the landing gear, NOT to raise or lower the trailer.

If you didn't know the answers to the above questions or are unsure of anything so far -- go back and review the program or ask your instructor for help.

If you have everything under control, TURN THE PAGE.

LET'S GET ON WITH THE PROGRAM!

7. Go to the left front corner of the trailer. Mounted on the frame, below the tank, on the left front corner you see a red trip lever. A cable runs from there to the emergency dump valves and during an operational emergency the dump valves can be closed by pulling this lever.

8. Move down the side of the trailer to the large "roadside cabinet" This cabinet has two large doors. Before you open these doors there are two things to check out:

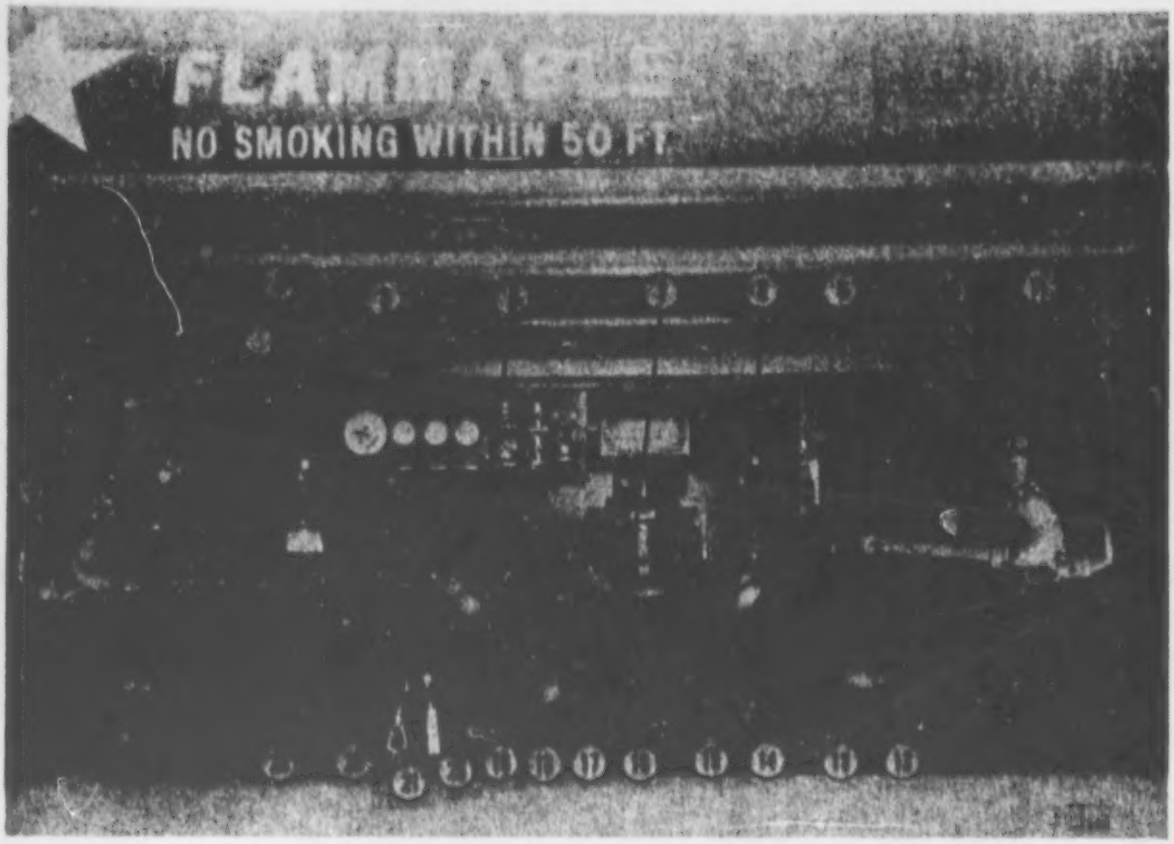
a. On the left side of the cabinet there is a red handle with a red cover. This is the "EMERGENCY CABINET FIRE EXTINGUISHER". CAUTION - DO NOT PULL THIS HANDLE!

This handle connects to a CO_2 cylinder inside the cabinet and when the handle is pulled the cylinder is immediately emptied and both "roadside" and "curbside" cabinets are filled with CO_2. It is a one shot operation and once used it has to be recharged by the fire department.

b. Look above the roadside cabinet. You see the long tubes which contain the hoses and the short tube containing the gage stick. Notice there is a small door on the front end of the large tubes. It is necessary to have a door at either end because to remove the hose you must open both ends and push the hose out about a foot in order to get a grip on the hose.

9. Your next step is to open the roadside cabinet. On the next page you see a picture of this cabinet. Listed below on this page is a list of each item in the cabinet by name. Go through this list one at a time and find each item in the cabinet.

1. 1 1/2 inch nozzle
2. 1 1/2 inch hose on reel (0-55 GPM dispensing)
3. Hose reel handcrank attached to shaft
4. Fire system nozzle
5. Control and instrument panel
6. Rate-of-flow selector valve
7. Meter
8. 225 GPM cutoff valve handwheel
9. Fire system nozzle (other location)
10. 2 1/2 inch hose on reel (225 GPM dispensing)
11. 2 1/2 inch nozzle
12. Hose reel crankshaft
13. Pump intake valve
14. Pump cutoff valve handwheel
15. Rear compartment manifold valve handwheel
16. Hose reel handcrank clamps
17. Gravity discharge valve
18. 3-way valve lever
19. Front compartment manifold valve handwheel
20. Pump discharge valve
21. Static reel
22. Emergency dump valve operating levers
23. Fire extinguisher



FLAMMABLE
NO SMOKING WITHIN 50 FT

10. After you have studied this list take a close look in the cabinet. You should be able to find a valve in the cabinet that is not on the list. Try now to find the valve in the cabinet that is not on the list.

11. Did you find the valve? It is behind the meter. We call this valve the "D" valve. It is used for defueling using the 225 GPM hose or gravity discharging through the meter and 225 GPM hose.

12. It is important that you know the names and locations of each piece of equipment in this cabinet. Take a few minutes now to study the list and picture, comparing it to the cabinet. When you are completely familiar with this phase of instruction, proceed to step IV, practical exercise. Contact your instructor.

PART IV

EXERCISE #1

The first exercise will require you to re-circulate the fuel and check and record the pressure differential. It is required that the fuel be re-circulated prior to being dispensed from the vehicle. Re-circulating the fuel removes water and sediment from the fuel and allows the vehicle operator to check and record the pressure differential.

Follow your instructions closely and if you have any problems, check with your instructor.

1. Place a fire extinguisher where it will be easy to get to but out of the way of the operation.
2. Take the ground wire from the trailer and connect it to the ground rod.
3. Take the gage stick from its compartment and determine how much fuel is in each compartment.
4. Perform operator's maintenance on the trailer and pump.

NOTE: See Annex 1 at the back of this booklet for the checklist on operator's maintenance.

5. Pull the 3-way valve lever out.
6. Open both manhold filler covers.
7. Open the emergency dump valve of the compartment to be used.
8. Open the compartment manifold valve of the compartment to be used.
9. Open the pump cut off valve.
10. Open the 225 GPM cut off valve.

11. Roll out the 225 GPM hose. Put the nozzle over the hatch of the compartment that you are going to re-circulate the fuel into.

12. You are now ready to start the pump. Starting the pump is a two man operation. The man beside the engine will open the fuel shut off valve and operate the manual choke by pulling it out about halfway and push it in after the engine starts. This step is not necessary on a warm engine and should only be done when the engine is cold.

NOTE: Should any malfunctions or major leaks occur, shut off the engine immediately and close all valves.

13. To start the engine -

a. Turn both toggle switches on the control panel to the on position.

b. Press starter button until engine fires, then quickly release. Do not hold the starter button down for more than 10 seconds at a time, as you could damage the starter.

14. As soon as the engine starts running, open the discharge nozzle. Insure the man operating the nozzle has a firm grip on it as it may jump when opened or closed. Re-circulate the fuel for five minutes. While you are re-circulating the fuel check and record the pressure differential as follows:

a. There are three pressure gages on the control panel in the roadside cabinet. From left to right as you face the gages, they are: the filter inlet pressure, the first stage outlet pressure and the filter outlet pressure.

b. While the fuel is being re-circulated, record the reading from each of the three pressure gages.

c. When there is a difference greater than 20 PSI between the filter inlet pressure and the filter outlet pressure, all filter elements and fuses must be changed.

d. When there is a difference greater than 15 PSI between the filter inlet pressure and the first stage outlet pressure, replace the first stage filter elements.

e. When there is a difference greater than 15 PSI between the first stage outlet pressure and the filter outlet pressure, replace the fuses.

15. After re-circulating the fuel for five minutes and checking and recording the pressure differential this operation is completed. Close all valves and return all equipment to its proper place.

EXERCISE #2

This exercise will require you to perform two operations. One operation is to discharge fuel by pump, through the pump discharge valve and the other operation will be to bottom load a tanker through its gravity discharge port.

NOTE: The fuel is not metered or filtered during this operation.

Your instructor assigned your group two semi-trailers to use. Follow your instructions closely and if you have a problem check with your instructor.

1. Take the gage stick from its compartment and determine how much fuel is in each tank.

2. You should have found one semi-trailer empty. If you did not find one empty notify the instructor immediately before going to the next step.

3. To make your instructions easy to follow we will call the trailer with fuel "Trailer A" and the empty trailer we will call "Trailer B". We won't change these trailer numbers so remember which is "A" and "B".

4. Bring a fire extinguisher from a fire point and place it where it will be easy to get to but out of the way of operations.

5. Open the roadside cabinets of both trailers.

6. Take the ground wires from trailer "A" and connect one to a ground rod and the other to trailer "B".

7. Take one ground wire from trailer "B" and connect it to a ground rod.

8. Place a large yellow drip pan under the gravity discharge port of each trailer.

9. Remove two discharge hoses from the hose compartment of trailer "A".

10. Connect the hoses together, then connect one end of the hose to the pump discharge port on trailer "A" and the other end to the gravity discharge port on trailer "B".

NOTE: Before continuing your next step, check with the instructor to be sure your hose is connected properly.

11. You will be pumping fuel from the front compartment on trailer "A". Do you know which valves to open on trailer "A" in order to do this? Perform the following steps in sequence on trailer "A"..

a. Pull the forward compartment emergency dump valve lever forward until it catches.

b. Open the front compartment manifold valve. Steps a and b allow fuel to flow from the front compartment into the manifold.

c. Open the pump cut off valve on the manifold. This allows fuel into the pump.

NOTE: In this operation the fuel will bypass the filter separator but to prevent recirculation pull the three way valve lever "out".

12. Now go to trailer "B". You are going to "bottom load" the rear compartment through the gravity discharge port. Do you know which valves to open? Perform the following steps in sequence.

a. Pull the rear compartment emergency dump valve lever forward until it catches.

b. Open the rear compartment manifold valve.

c. Open the gravity discharge valve.

d. The three way valve should be in.

NOTE: Trailer "B" is now ready to receive fuel in the rear compartment. Before you go to the next step have the instructor check out your valves.

13. Perform operators maintenance on trailer "A" pump and motor.

NOTE: See Annex #1 for check list on operators maintenance.

14. Before starting the pump make sure the front hatch cover on trailer "A" and the rear hatch cover on trailer "B" is open. Place one student on top of trailer "B" to watch fuel received in the rear tank. Place one student beside engine and pump on trailer "A". Place one student at each of the roadside cabinets.

15. You are now ready to start the pump. Follow the procedures discussed in exercise number 1 when starting the pump. As soon as the pump starts running, open the pump discharge valve.

16. After operating the pump about three minutes, turn off the engine by putting both toggle switches in the off position. Then close the pump discharge valve.

17. Take a gage on the rear tank of trailer "B" and a gage on the front tank of trailer "A". The trailer "B" should have gained what trailer "A" lost.

18. All students change positions and repeat the operation. Continue to switch and operate and gage until all the students in your group understand the operation. After each student is familiar with each part of this operation go to step 19. Make sure you know these operations, you'll be tested on them.

19. At this time the pump should be off. Close all valves on both trailers.

EXERCISE #3

Having closed all valves on both trailers you are ready to start the third part of this practical exercise. This part will involve two different operations of the M131A5C semi-trailer. The first operation will be "gravity flow discharge" from trailer "A" and the other operation will be to "bottom load" trailer "B" using its own engine and pump.

After any operation using the three inch hoses you should drain the hoses. However, you will be using these hoses again so we will save this step until after this part of the PE.

1. You will be "bottom loading" the forward compartment of trailer "B" using the pump and motor on trailer "B" so perform the operators maintenance on the trailer "B" engine now.

2. You will "gravity flow discharge" from the rear compartment of trailer "A" so remove the dust cap from the gravity discharge port and move the hose from the pump discharge port to the gravity discharge port then replace the dust cap on the pump discharge port. Place a spill container under the hose to preclude spilling fuel on the ground.

3. You will be using the pump on trailer "B" so on trailer "B" remove the dust cap from the pump intake port and move the hose from the gravity discharge port to the pump intake port do not place a dust cap on the gravity discharge port.

4. On trailer "B" remove a 3 inch hose section from the hose compartment.

5. On trailer "B" connect this hose between the pump discharge port and the gravity discharge port.

6. Open the manhole covers on the rear compartment of trailer "A" and the forward compartment of trailer "B".

7. To "gravity flow discharge" from the rear compartment of trailer "A", open the following valves on trailer "A" in this order.

   a. Rear compartment emergency dump valve.

   b. Rear compartment manifold valve.

   c. Gravity discharge valve.

8. To "bottom load" the forward compartment of trailer "B", open the following valves of trailer "B" in this order

   a. Pump intake valve.

   b. Gravity discharge valve.

   c. Forward compartment manifold valve.

   d. Forward compartment emergency dump valve.

9. You will also have to open the pump discharge valve on trailer "B" when you start the pump, but before you start the pump, have the instructor check your hose connections and valve settings.

10. After the instructor has checked out your valves and hoses, place one student on top of each trailer. Place one student by the pump on trailer "B". Place one student by each manifold cabinet.

11. Start the pump on trailer "B" and open the pump discharge valve.

12. After pumping about 3 minutes, stop the pump and close the pump discharge valve.

13. Have the students change positions and repeat steps 10, 11 and 12. Do this several times if necessary to insure each student in your group is familiar with the operation. Make sure you know this operation; you'll be tested on it.

14. After each student is familiar with this operation, turn off the engine and close all valves on both trailers.

15. Your next step will be to drain the 3-inch hoses. To do this you will need two 3-inch dust plugs. The first hose to drain will be the hose on trailer "B" from the pump discharge port to the gravity discharge port. To do this follow these steps in order.

a. Disconnect the hose from the pump discharge port, raising it a little after disconnecting to prevent spillage.

b. Quickly insert dust plug in the hose and clamp tightly.

c. Lay the dust plug end of the hose on the ground.

d. Disconnect the hose from the gravity discharge port, raising it a little to prevent spillage.

e. Quickly insert a dust plug in the hose and clamp tightly.

f. Cover the discharge ports with dust caps.

g. Lift the hose and lay it on top of trailer "B" with one end over the open front hatch.

h. CAUTION: Remove the dust plug over the open hatch being careful not to drop the plug in the open hatch.

i. Raise the other end of the hose to shoulder height and remove the dust plug.

j. Thoroughly drain the hose and return it to the hose locker on the side of the trailer.

16. Your next step will be to drain the double section of hose connecting the two trailers. Do this in the same manner as you did the first hose, starting on the trailer "B" end of the hose since it is higher than the other end.

17. After returning the double section of hose to its locker on trailer "A", perform after operation maintenance on both trailers. NOTE: See Annex #1 for check list.

EXERCISE #4

For this portion of your Practical Exercise you will have to discharge fuel from the M131A5C semi-trailer using the pump and engine on the trailer and discharging through the 225 GPM dispensing hose.

1. Your drip pans and fire extinguisher should still be handy so perform "before operations maintenance" on trailer "B".

2. Open the roadside cabinets of both trailers and ground and bond the trailers as you did in Exercise #1 of this PE.

3. Open all four manhole covers on top of the trailers.

4. You will be pumping the fuel from trailer "B" to trailer "A" so on trailer "B" roll out sufficient 225 GPM hose and put the nozzle over the forward hatch of trailer "A".

5. Place one student by the engine of trailer "B". Place one student on top of each trailer. The student on top of trailer "A" will operate the nozzle. The other students in your group will be at the roadside cabinet of trailer "B".

6. The object now is to pump the fuel from the forward compartment of trailer "B" to the forward compartment of trailer "A". Open the following valves on trailer "B".

a. Forward compartment emergency dump valve.

b. Forward compartment manifold valve.

c. Pump cut off valve

d. Pull 3-way valve lever "out".

e. 225 GPM cut off valve.

NOTE: Before going to step 7 have the instructor check out your valves.

7. Start the engine and open discharge nozzle. If you don't get a discharge within 30 seconds, shut off the pump and notify the instructor.

8. Continue pumping until all the fuel from the forward compartment is transferred.

9. Shut off the engine and close all the valves.

10. Have the students change places so that the ones who were on the trailers and by the engine are now by the roadside cabinet.

11. Place nozzle over the rear compartment of trailer "A".

12. You will be pumping fuel from the rear compartment of trailer "B" to the rear compartment of trailer "A", so open the following valves on trailer "B".

a. Rear compartment emergency dump valve.

b. Rear compartment manifold valve.

c. Pump cut off valve.

d. Pull 3-way valve "out".

e. 225 GPM cut off valve.

NOTE: Before going to step 13, have the instructor check your valves.

13. Start the engine and open the discharge nozzle. If you do not get a discharge within 30 seconds, shut off the engine and notify the instructor.

14. Continue pumping until all the fuel is transferred.

15. After completing the transfer, shut off the engine and close all valves.

16. Return the hose to its reel.

17. Close all hatches.

18. Perform operators "after operation maintenance". (See annex #1 for check list.)

19. Secure all equipment and clean up any spills.

20. Return the drip pans and fire extinguisher to proper storage.

You have now completed the physical portion of this practical exercise. Review your work up to this point. You will be required in your examination to know where to hook up your hoses and what valves to open for all six of the operations performed in this PE. You will also be required to know what is done in before, during and after operations maintenance. You will also be tested on safety procedure.

Review your work, and if you have any questions ask your instructor for clarification.

EXERCISE #4

This portion of your practical exercise is a written quiz to help you prepare for the examination. Answer all these questions by looking at the M131A5C but do not look at the preceding pages of this workbook or the answer sheet. This exercise is not graded but can be a big help on your exam if you don't take shortcuts.

1. How many different operations of the M131A5C did you perform in this PE? ______________________________

2. What valves do you open to "gravity discharge" from the rear compartment? ______________________________

____

3. In discharging from the forward compartment using the 225 GPM hose dispenser, what valves are open and what is the position of the 3-way valve?

____

____

4. What valves would be opened to "bottom load" the rear compartment using a 350 GPM pump to push fuel to the trailer? ______________

____

____

5. What valves would you open to "bottom load" the rear compartment using the engine and pump of the trailer you are loading and what is the 3-way valve position? ______________________________

____

____

374

6. What valves would you open to pump fuel from the forward compartment and out the 3-inch pump discharge port? ________________

____

____

7. What gate valve in the roadside cabinet was not used in any of the operations you performed in this PE? ________________

____

ANSWERS TO EXERCISE #4 QUIZ

1. Six.
2. Rear compartment emergency dump valve

   Rear compartment manifold valve

   Gravity discharge valve
3. Forward compartment emergency dump valve, pump cut off valve, forward compartment manifold valve, nozzle, 225 GPM cut off valve, 3-way valve "out".
4. Gravity discharge valve, rear compartment manifold valve, rear compartment emergency dump valve.
5. Pump intake valve, pump discharge valve, gravity discharge valve, rear compartment manifold valve, rear compartment emergency dump valve, 3-way valve "in".
6. Forward compartment emergency dump valve, pump cut off valve, forward compartment manifold valve, pump discharge valve.
7. This was a tricky question. You did not operate the 0-55 GPM dispensing unit but if you'll notice, there is no gate valve between the meter and hose. The answer is the "D" valve behind the meter. The only time the "D" valve is used is to "gravity discharge through the meter" or to "defuel using the 225 GPM hose". You will not be tested on this, but it is well to know it. If you would like more information on this, ask your instructor.

Compare your answers with the correct answers and if you disagree with any of them, find out where the problem is. When you are satisfied that you can perform before, during and after operations maintenance

376

and when you are sure you can perform all six operations you practiced in a safe manner, then inform your instructor you are ready for your exam.

ANNEX #1

Before Operations Maintenance:

1. Check tank compartments:

   a. If tanks contain fuel, take a gage and sample to determine quantity and quality of fuel.

   b. If tanks are empty, check to make sure they are clean and free of any water or dirt, etc.

2. Check hose compartment for:

   a. Three hose sections in good condition.

   b. One gage stick in good condition

3. Check roadside cabinet to assure:

   a. All valves closed.

   b. Fire extinguishers charged.

   c. Ground reel operational.

   d. Clean nozzle screens

   e. Hoses in good condition.

   f. No missing or damaged equipemnt

4. Check curbside compartment for:

   a. Engine oil proper level.

   b. Battery water proper level and cables tight.

   c. Gas tank 3/4 full.

   d. Sediment bowl free of dirt and water.

   e. No loose or damaged parts.

5. Check filter separator for:

   a. Leaks or visible damage.

   b. Drain any water in sump.

During Operations Maintenance:

1. Watch for leaks.
2. Listen for unusual noises.
3. Watch for bulges in hoses.
4. Check pressure differential.
5. Check engine air breather.
6. Watch gas supply.

After Operations Maintenance:

1. Same as "before operations maintenance."
2. Complete TAMMS forms as required.
3. Clean all equipment and store it properly.

QMS 300.439 H-1
Part II

TANK VEHICLE OPERATIONS

M49A2C

LEARNING/PERFORMANCE GUIDE

PROPONENT DEPARTMENT: Petroleum and Field Services

March 1977

THIS SUPERSEDES QMS 300.439H1 Part 2
DATED NOVEMBER 1976.

INTRODUCTION:

The use of the tank vehicle in the United States Army is increasing because of the need for large amounts of bulk fuels and rapid deliveries of bulk fuels. This booklet will teach you the description, maintenance, and operation of the M49A2C tank vehicle. The M49A1C is another model of this tank vehicle, however we don't have one to train you on. Procedures you will follow if you run across one after you leave the school are in Annex A at the end of this program.

OBJECTIVES:

As a result of this instruction, you, the student, will be able to:

1. Perform operator's maintenance on the tank vehicle.
2. Circulate fuel and record pressure differential.
3. Fuel and defuel petroleum containers and aircraft using the tank vehicle.

INSTRUCTIONS TO STUDENTS:

This program contains all the information you will need to be able to perform the objectives listed above. Follow all directions, and do not skip ahead. If you have any problems or do not understand something, call your instructor. When you finish this program, you will be given a performance test on all the material it contains. GOOD LUCK!

GO TO THE PETROLEUM TRAINING FACILITY AND THE M49 TANK VEHICLE INSTRUCTOR BEFORE YOU BEGIN THIS PROGRAM.

381

LESSON 1.

DESCRIPTION:

M49A2C

The M49A2C tank truck is equipped with a stainless steel, 1,200 gallon tank body, which is divided into two 600-gallon compartments. Each compartment has a Manhold Cover Assembly (up top) that allows entry into the tank compartment for gaging, maintenance, and top loading the vehicle. Each compartment is connected by a piping system (controlled by valves) that allows the product to enter into a manifold system before entering the Delivery Pump. Because the tanker only has two compartments, there are only two discharge operating control levers. The controls for the vehicle are located in the rear of the vehicle in a cabinet called the Equipment Compartment (Fig 1). The cabinet also houses the Delivery Pump, the Filter Separator, and the Meter with necessary valves for operation of the vehicle.

FUEL HANDLING CONTROLS:

1. The Delivery Pump is connected to the truck engine by Transfer Power Takeoff. Control of the pump is accomplished by movement of the Power Takeoff Shifting Lever (Fig 2). You will learn more about this as we go on.

2. Discharge Valve Control Operating Levers:

Each Discharge Valve Control Assembly (Fig 1) controls one Discharge Valve located at the bottom of each tank compartment. Pulling back on a lever opens a Discharge Valve and permits the flow of fuel out of the tank compartment and into the piping system. Squeezing the Trip Rod Operating Handle, mounted on the lever, and allowing the lever to be moved forward, closes the valve and shuts off the flow of product out of the tank compartment.

3. Delivery Line Gate Valves:

The two Delivery Line Gate Valves (Fig 1) are provided to control delivery line product flow. One valve, located on the lower right side of the rear compartment, controls the flow through the delivery line when fuel is gravity discharging from the vehicle (Fig 1). The other valve, located near the right side of the Delivery Pump, controls the delivery line that is used for power discharge through the dispensing hose and pump; the hose is stowed on the left side of the tank body. The valves are manually turned to the left to open, and to the right to close.

4. Automatic Dump Valve Drain Tube: (Fig 1)

This valve is opened to drain water from the Filter Separator during operation. It should be opened before operation and left open until after the operation is completed. The automatic crain valve is located below the manual drain valve.

5. Manual Water Drain Valve:

This valve is also opened to drain water from the Filter Separator Pump. Open until fuel appears; then, close immediately before operating the tanker.

6. Grounding Wire:

A grounding wire (Fig 1) on a Spring-loaded Reel is pulled out and attached to a ground before pumping operations begin. An Alligator Clip is attached to the end of the wire.

LESSON 2:

OPERATOR'S MAINTENANCE:

There are three types of maintenance performed on the tank vehicle. (1) Before Operators Maintenance - These are maintenance checks performed before the operation begins. (2) During Operator's Maintenance - This is maintenance performed while the operation is being performed. (3) After Operator's Maintenance - These are maintenance checks performed after an operation has been performed.

BEFORE OPERATOR'S MAINTENANCE:

An instructor will demonstrate to you the Before Operator's Maintenance checks. Pay close attention to the instructor, and follow the below procedures:

1. Check engine oil level: add oil if necessary until it reaches the full mark on the stick.

2. Check Radiator for water level: you should be able to see water in the neck of the Radiator.

3. Check Battery for water and corrosion.

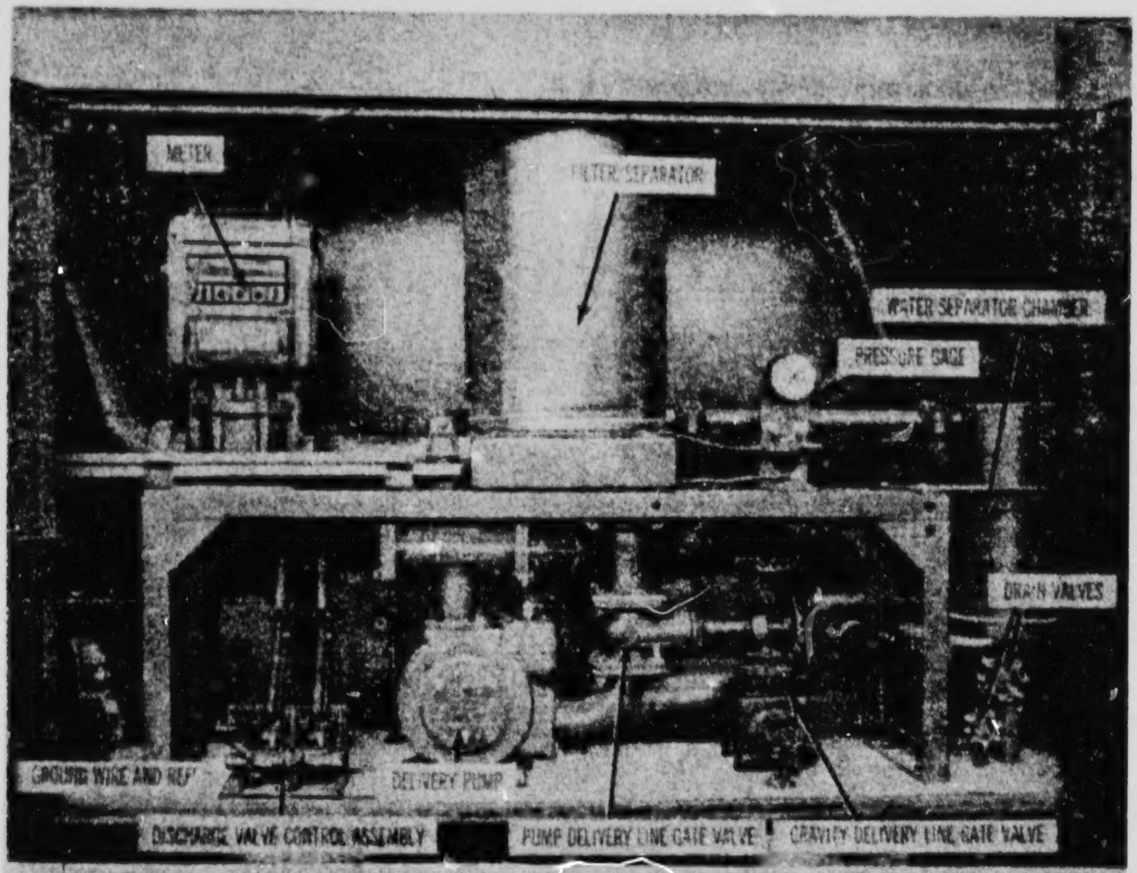

METER
FILTER SEPARATOR
WATER SEPARATOR CHAMBER
PRESSURE GAGE
DRAIN VALVES
GROUND WIRE AND REE
DELIVERY PUMP
DISCHARGE VALVE CONTROL ASSEMBLY
PUMP DELIVERY LINE GATE VALVE
GRAVITY DELIVERY LINE GATE VALVE

Figure 10. Rear equipment compartment of M49A2C tank truck.

FIG 1

4. Open Filter Separator Manual Drain Valve until fuel appears, then close.

5. Open Automatic Dump Valve (with Drain Tube), and leave open during operation.

6. Remove and check strainer in nozzle of Dispensing Hose for clogs and dirt.

7. Check for loose wires and bolts throughout the whole unit.

8. Fill out TAMMS forms.

DURING OPERATIONS MAINTENANCE:

1. Listen for unusual noise in pump.

2. Check for excessive vibrations of pump.

3. Check for leaks in Equipment Compartment and hose connections.

AFTER OPERATIONS MAINTENANCE:

1. Check engine oil level (add if needed).

2. Check fuel tank (make sure that tank is 3/4 full).

3. Check Radiator for water level.

4. Open Manual Drain Valve for Filter Separator until fuel appears, then close.

5. Close Automatic Dump Valve Drain Tube.

6. Check Battery.

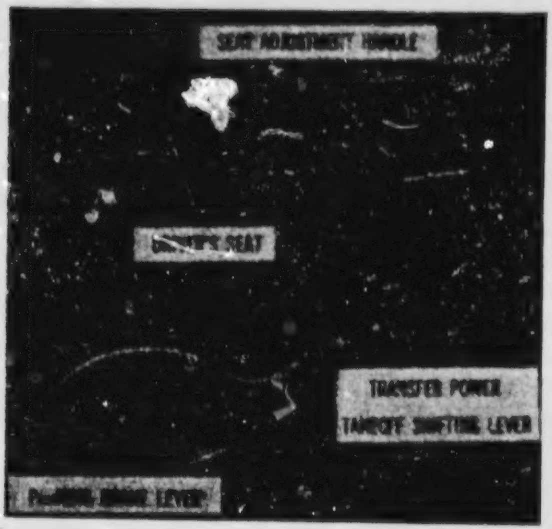
7. Clean all equipment.

8. Complete TAMMS forms.

RECORDING PRESSURE DIFFERENTIAL:

When recording pressure differential on the tank vehicle, the procedures for the M49A1C are somewhat different than they are for the M49A2C; therefore, we must learn them individually. Keep in mind that fuel must be circulating when pressure differential is checked.

GO ON TO THE NEXT STEP


SEAT ADJUSTMENT HANDLE
DRIVER'S SEAT
TRANSFER POWER
TAKEOFF SHIFTING LEVER
PARKING BRAKE LEVER

NOTE: Look on page15,this is the form you will use to record the pressure differential readings talked about below.

M49A2C:

The primary difference between the Filter Separator on the M49A1C and M49A2C is the Filter Separator on the M49A1C has only filter elements, and the M49A2C has filter elements and go-no-go fuses. The filter elements collect solid contaminants and separate water from the fuse. The go-no-go fuses shut off fuel flow if water or solid contaminants exceed a safe level; the shutoff flow indicates that the filters are not operating properly and that you must notify your supervisor immediately. The procedures for taking the pressure differential reading are as follows:

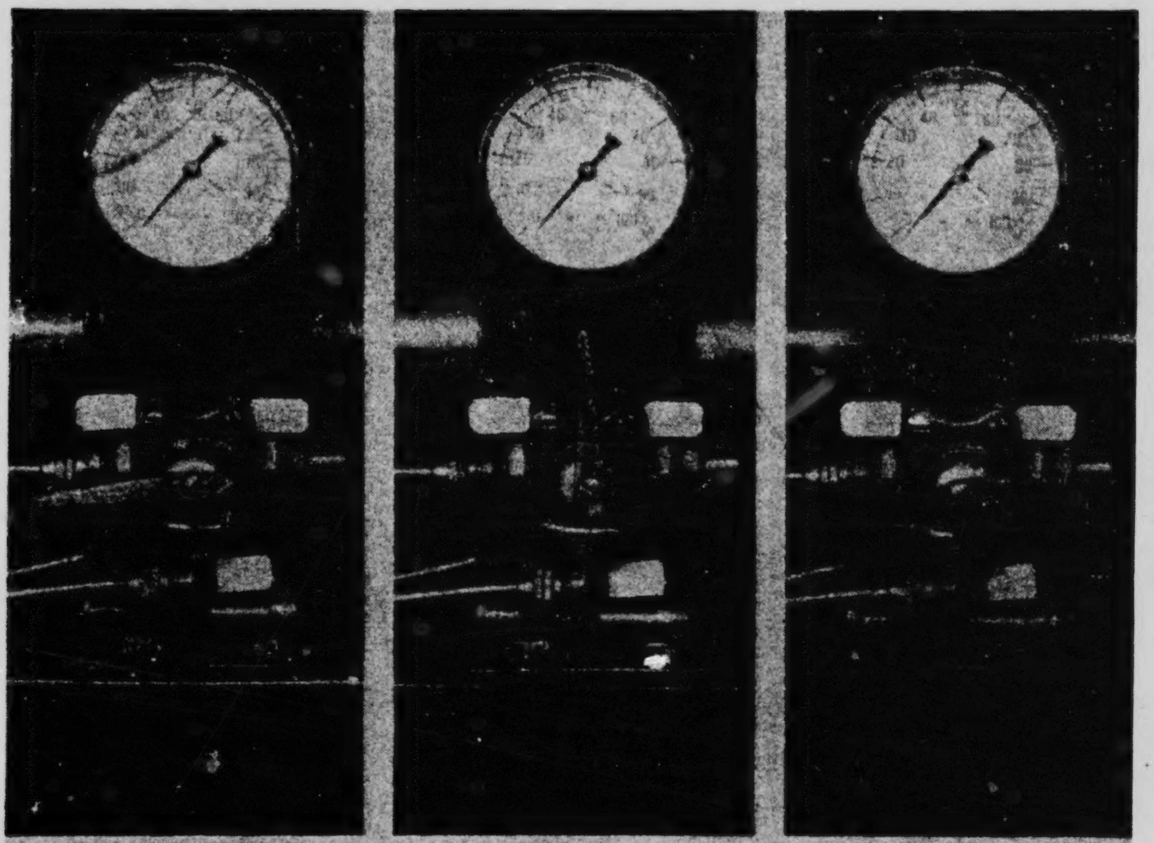
1. Turn handle clockwise so that it will be pointing to the extreme left and record the reading; this will give you the inlet reading (Fig 4 #1).

2. Turn the handle clockwise until it points straight up and record the reading; this will give you the outlet side reading (Fig 4 #2).

3. Turn the handle clockwise so that the handle will be pointing to the extreme right, and this will give you the internal pressure reading.

When pressure differential between the outlet side and the inlet side exceeds 20 psi, stop operating and notify your supervisor immediately. When the pressure differential between the inlet pressure and the internal pressure exceeds 15 psi, notify your supervisor immediately. When the pressure differential between the outlet pressure and the internal pressure exceeds 15 psi, notify your supervisor immediately.

NOTE: The fuel must be circulating when the pressure differential is checked. You will check this while circulating fuel in Lesson #3.



1. TURN HANDLE CLOCKWISE AND TAKE READING ON INLET SIDE

2. TURN HANDLE CLOCKWISE AND TAKE READING ON OUTLET SIDE

3. TURN HANDLE CLOCKWISE AND TAKE READING ON INTERNAL PRESSURE SIDE OF VALVE

Lesson 3:

Now that you have learned the components of the tank vehicle, this lesson will teach you how to circulate the fuel and take pressure differential on the filter separator. Remember, you should circulate fuel through the filter separator before you dispense any fuel anytime. By doing so you can be sure that the fuel you dispense is free of water and other contamination.

At this time, a demonstrator will show you how to start the vehicle's engine and ENGAGE the pump for operation. Pay close attention to the demonstrator. You will not start the truck engine or engage the pump, your instructor will. Army regulations state that if you don't have a valid driver's license you can't start the engine. You'll be "driver qualified" at your next duty station, so pay attention to this lesson.

STARTING ENGINE:

1. Bond and ground the vehicle.

2. Place fire extinguishers where they can be easily reached in case of fire.

3. Make sure that the Handbrake is in the ON position (Fig 2) by pulling UP on the Handbrake Handle.

4. Depress the Clutch Pedal and put the Transfer Case in NEUTRAL position.

5. Place the Transmission in 2d gear, and release the Clutch Pedal.

6. Put Ignition Switch in the ON position.

7. Press the Start Button and the engine should start immediately.

8. After engine is running, depress the Clutch and ENGAGE the pump by pulling back on the Power Takeoff Shifting Lever (Fig 2). Release the Clutch slowly, and you should feel the pump go into operation.

CIRCULATING FUEL AND DISPENSING OPERATION:

Read carefully through all the steps listed below; then come back to step 1 and actually do what each step tells you to do.

1. Open the Discharge Valve Control Assembly Lever for the tank that you are going to be pumping out of (Fig 1).

2. Open the Delivery Line Gate Valve just to the right side of the delivery pump (fig 1).

3. Open the Automatic Dump Valve Drain Tube (Fig 1).

4. Remove the Dispensing Hose from the side of the tank body and put the nozzle into the same compartment that you are going to be pumping out of.

5. Increase engine speed to 1100 rpm's by pulling slowly out on the Throttle Handle. Turn the hand vertically (up and down direction) to lock it in position.

6. Squeeze the nozzle and the product will circulate from the tank compartment through the manifold system to the Delivery Pump through the Filter Separator through the meter out the Dispensing Hose back into the same compartment that you are pumping out of. Trace the flow of fuel and see what we are talking about!

NOTE: Take a pressure differential reading at this time and record the readings on the form on page 15.

Practice this operation until you are thoroughly familiar with the procedures. When you feel that you can circulate fuel and take pressure differential readings, go on to the next part of this lesson.

DISPENSING:

When filling either cans, drums, or with the tank vehicle, use the same procedures that you used when circulating the fuel; except this time, insert the nozzle into the container or vehicle. When filling petroleum containers such as drums or cans, maintain metal-to-metal contact between the nozzle and the containers throughout the entire refueling operation. When refueling vehicles, ground and bond the receiving vehicle to the tank vehicle you're pumping out of.

Using the procedures listed above, fill the 55 gallon drums located on the rear of the vehicle.

Practice the dispensing operation until you know it, then, go on to the next part of this lesson.

DEFUELING PETROLEUM CONTAINERS:

In this part of the lesson you will learn how to use the M49A2C to take fuel out of the drums you just filled and return it to the compartments on the tanker.

1. Remove cap from one 10-foot section of 1-1/2 inch gravity dispenser hose, and attach it to the Gravity Delivery Line Gate Valve in the right side of the rear equipment compartment. Attach a drum suction stub to the other end of this hose and insert it into the container you are going to defuel.

2. Open the Automatic Dump Valve Drain Tube and both Delivery Line Gate Valves.

3. Make sure that all Discharge Control Operating Levers are in the closed position.

4. Open the tank compartment to be filled on tank vehicle (hatch on top).

5. Insert the Dispenser Nozzle into the tank compartment hatch.

6. Start the engine and engage the pump.

7. Adjust the Throttle Control and increase rpm's; the pump will suck fuel from the container, pump it into the tank compartment.

8. When the container is emptied, stop the engine and perform After Operator's Maintenance on the tanker.

AIRCRAFT REFUELING:

This part of the lesson will teach you how to refuel aircraft using the M49A2C tank vehicle. Follow all the directions given in the "Recirculation and Dispensing" portion of this lesson to actually pump the fuel. Because aircraft refueling can be a dangerous operation, certain extra precautions must be taken:

1. Approach aircraft from the side and to the rear of the wing. The important thing is to approach in such a way that if the tanker brakes fail, you won't hit the aircraft.

2. Park tank vehicle at least 20 feet away from the aircraft.

3. Park vehicle facing away from the aircraft so that in case of accident or fire, you can get away quickly.

4. Ground and bond the tanker and aircraft. Your instructor will show you--ask him!

5. Place fire extinguishers and "No Smoking" signs in the appropriate areas.

Practice operating the M49A2C using the instructions contained in this program booklet. When you feel you can refuel aircraft, fill containers and defuel them, and perform Operator's Maintenance on the tank vehicle, tell your instructor that you are ready to take the test. BE SURE YOU ARE READY!

ANNEX A

OPERATION OF THE FILTER SEPARATOR

M49A1C:

The filter separator removes water and solid contaminants, such as dirt, rust, and scale from the fuel through filter elements. It must be used when aircraft are being refueled!! The Pressure Gage, located on the bottom of the Filter Separator, tells you how dirty the filter elements are by indicating the pressure differential between the inlet side and the outlet side of the Filter Separator. (The greater the difference between these two readings, the dirtier the elements are.) The gage has a three position Valve Handle as shown in Fig 3 of this booklet. Pressure differential readings should be recorded every time you operate the vehicle and a record of the readings is maintained. The procedures for taking a reading and recording are as follows:

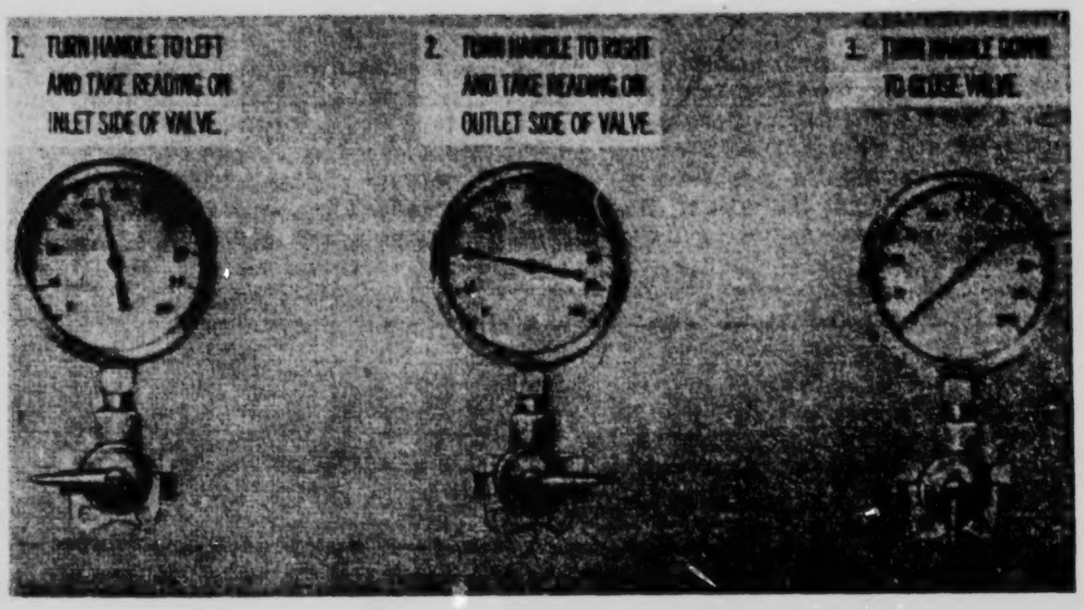
1. You must always start with the handle of the valve in the down position as shown in Fig 3 #3.

2. Turn handle to the left, and take a reading on the inlet side of the Filter Separator (Fig 3 #1), and record on paper.

3. Turn handle to the right and take a reading on the outlet side of the Filter Separator (Fig 3 #2), and record on paper.

4. Turn handle down to close valve.

Now, subtract the reading of the outlet side from the reading on the inlet side, and this will give you the pressure differential. Anytime there is a difference of 15 psi in the readings, or the pressure takes a sudden drop, stop operation and notify your supervisor immediatley.


1. TURN HANDLE TO LEFT AND TAKE READING ON INLET SIDE OF VALVE.
2. TURN HANDLE TO RIGHT AND TAKE READING ON OUTLET SIDE OF VALVE.
3. TURN HANDLE DOWN TO CLOSE VALVE.

MICRONIC FILTER DIFFERENTIAL PRESSURE – FUEL SERVICING EQUIPMENT

(DAILY LOG)

SAMPLE

NOTE ANY SERVICES TO FILTERS ON REVERSE SIDE

EQUIPMENT NOMENCLATURE

FILTER SERIAL NR

DATE	INLET PRESSURE	OUTLET PRESSURE	F/S OUTLET PRESSURE	DIFFERENTIAL	DIFFERENTIAL ACROSS FUSES	INIT	DATE	INLET PRESSURE	OUTLET PRESSURE	F/S OUTLET PRESSURE	DIFFERENTIAL	DIFFERENTIAL ACROSS FUSES	INIT

DATE	SERVICE PERFORMED

162

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PETROLEUM SUPPLY SPECIALIST
MOS 76W10

INSTRUCTOR GUIDE
Annex D

U.S. ARMY QUARTERMASTER SCHOOL
FORT LEE, VIRGINIA

SUPPLY TRAINING CENTER OF THE ARMY SCHOOL SYSTEM

ATSM-TNG-TM-ET

MAY 1978

Army-Fort Lee, Va.-1299-78-100-1

TABLE OF CONTENTS

Paragraph	Title	Page
1	Purpose	1
2	Annex Goals	1
3	Instructional Organization and Responsibility	1
4	Student Morale and Control	1
5	Control and Distribution of Materials	1
6	Methods of Instruction	1
7	Pretesting	2
8	Student Records	2
9	Contents of Annex D	2
10	Conducting Instruction on Block D-11: Introduction to Terminal Operations	2
11	Conducting Instruction on Block D-2: Gaging Storage Tanks	3
12	Conducting Instruction on Block D-3: Gaging Tables and Volume Corrections	4
13	Conducting Instruction on Block D-4: Sampling Bulk Petroleum	5
14	Conducting Instruction on Block D-5: Valves, Pipes, and Fittings	5
15	Conducting Instruction on Block D-6: Manifolds	6
16	Conducting Instruction on Block D-7: Transfer Pump	8
17	Conducting Instruction on Block D-8: Rail Tank Car	9
18	Conducting Instruction on Block D-9: Tank Maintenance	10
19	Conducting Instruction on Block D-10: Waterfront Operations	11
APPENDIX A	Course Map - Annex D	12
APPENDIX B	Instructor Control Card	13
APPENDIX C	References	14

INSTRUCTOR GUIDE

76W, PETROLEUM SUPPLY SPECIALIST

Annex D, Terminal Operations

1. PURPOSE. This guide provides you, the instructor, with the necessary direction to conduct the course. This guide is not a technical manual of subject matter covered in this annex. When questions arise for which you cannot find the answers in this guide, use the references listed with each block of instruction.

2. ANNEX GOALS. The goals of this annex are to teach enlisted personnel some of the basic job skills pertaining to petroleum terminal operations. The different types of operations performed and equipment used are discussed in the annex. For example, students are taught how to sample, gage, and record temperature of petroleum products. They will also perform inspection and maintenance on valves, pipes, fittings, and manifold systems used in bulk petroleum operations. The single-stage pump unit used for transferring fuel from one container to another is also taught, as well as the use and function of rail tank cars. The instructional blocks on tank maintenance and waterfront operations are optional since there are no self-paced materials developed for these blocks.

3. INSTRUCTIONAL ORGANIZATION AND RESPONSIBILITY. If you have a sufficient number of qualified personnel, a team of instructors should be formed. The team should consist of a team chief (E6 or E7) and assistant instructors (E5 or E6). The team chief is the senior instructor responsible for the overall conduct of the instruction. This arrangement eases the job of training and lends itself to individualized instruction.

4. STUDENT MORALE AND CONTROL. As an instructor you should be alert to signs of student difficulties and make every effort to solve problems. Students who progress rapidly should be allowed to go on to the next lesson, or be assigned as a student aid to help other students with learning difficulties. Students who are slow but conscientious workers must be encouraged to continue studying. Never ridicule a student. Give praise and commendation for progress whenever merited. Students who refuse to apply themselves or do not pay attention should be counseled. Students who continue to have problems not directly related to learning difficulties (i.e., inability to read or comprehend) should be referred to command.

5. CONTROL AND DISTRIBUTION OF MATERIALS. This is a self-paced course. Students should be free to progress through the annex at their own speed. Before beginning a block of instruction, you should provide your students with all handouts, references, and programed texts (PT's). When the student

has completed the reading assignment and indicates he/she is ready, administer the checklist examination. Students are expected to achieve a score of at least 70% in two attempts. A pretest counts as one attempt. Students should not be allowed to go on to a block of instruction until they have successfully completed all preceding blocks. Remember, all programed texts are self-teaching materials which contain step-by-step explanation and demonstration, review, and self-grading performance requirements. Because each instructional block includes a complete processing procedure, each block must be completed in the sequence shown on the course map (Appendix A).

6. METHODS OF INSTRUCTION. Individualized instruction is tailored to the needs of the student. The instructor should circulate among the students to answer questions and insure they will finish in the prescribed time. Text materials are written at the seventh to ninth grade reading level. This will be well within the grasp of most students; however, instructors should be alert for students with reading comprehension problems.

7. PRETESTING. If a student indicates he/she knows the material before studying the instruction, you may pretest the student. Give the individual a copy of the pretest examination to review. If the student is able to achieve 70% on the checklist examination allow him/her to proceed to the next block of instruction. If the student does not achieve the required 70% have him/her study the material and prepare for a retest.

8. STUDENT RECORDS. Student folders and control cards must be prepared for each student enrolled in the course. These records should reflect the students' progress, time expended on each block of instruction and examination scores. Copies of records, counseling and other pertinent remarks you consider vital should be attached to the student control card. When a student completes an annex you should give these records to the student's next instructor. A sample format is attached at Appendix B.

9. CONTENTS OF ANNEX D. This annex covers terminal operations for a petroleum pipeline system. It contains eleven instruction blocks, one of which has been deleted and incorporated into another block. Terminal operating principles, procedures, and practices are discussed as well as the operation and maintenance of terminal equipment.

10. CONDUCTING INSTRUCTION ON BLOCK D-1: INTRODUCTION TO TERMINAL OPERATIONS. This block of instruction is an orientation hour in which the subject areas to be covered in Annex D are discussed. Terms and phrases peculiar to the operation of petroleum pipeline terminals are explained. However, since no written materials have been developed for this block, there are no performance or written requirements expected by the student.

11. CONDUCTING INSTRUCTION ON BLOCK D-2: GAGING STORAGE TANKS. This block of instruction covers the procedures for gaging storage tanks and sampling bulk petroleum (formerly Annex D-4). The student is taught the steps for measuring the depth of liquid and the amount of bottom sediment and water in a petroleum storage tank by the innage method. This block also covers procedures for taking the temperature of petroleum products while gaging and how to determine the proper depth at which to take the product temperature and length of time the thermometer is left in the product at various levels.

a. Objective.

(1) Condition. The student is placed in the position of a petroleum supply specialist in a petroleum training facility and provided with standard samplers, sample containers, sample tags, gaging equipment, and a gaging and sampling guide.

(2) Actions. The student will:

(a) Take a bottom sample from a bulk storage tank according to step-by-step procedures and fill out a petroleum sample tag (DA Form 1804).

(b) Identify different sampling methods and techniques.

(c) Take a multitank sample from a tank farm complex.

(d) Take an all-level sample from a storage tank.

(e) Measure bottom sediment and water in a bulk storage tank.

(f) Subtract measured volume of bottom sediment and water from product volume.

(g) Record average temperature of petroleum product in a bulk storage tank.

(h) List safety precautions and procedures involved when gaging petroleum storage tanks.

(3) Standard. The student must perform or answer correctly at least 70 percent of the performance tasks or written requirements on the annex examination.

b. Logistical Requirements.

(1) Materials. Paper, pencil, Student Guide, DA Form 1804.

(2) References. TM 10-1101, Petroleum Handling Equipment and Operation.

(3) Setting. Classroom, Petroleum Training Facility.

(4) Allotted Time. 14 hours. (Note: The time indicated for each block is not a fixed time limit. It is a suggested time frame based on past experiences that the average student needed to complete the instruction block. Since this is a self-paced course of instruction, the instructor is free to increase or decrease the allotted time to each student's particular need or capability.)

(5) Equipment. Gaging kit, weighted copper beaker, weignted glass, bottle, sample can, and rags.

c. Directions for Carrying Out Instruction. Make sure the steps below are followed during the instruction process.

(1) Step 1. Have students read and study the appropriate material in TM 10-1101 pertaining to gaging petroleum storage tanks and sampling bulk petroleum.

(2) Step 2. Have students read and study QMS 300.503H-1, Sep 76, on gaging and sampling procedures.

(3) Step 3. Have students read and complete the practice exercise in QMS 300.503H-1, Nov 76, for gaging storage tanks and taking product temperature.

(4) Step 4. Have students read and complete the practice exercises in QMS 300.506H-1 pertaining to sampling petroleum products.

(5) Step 5. Have students do practical exercise QMS 300.503PE-1, Sampling and Gaging.

(6) Step 6. When you are satisfied that the students have performed or answered all written requirements correctly, let them proceed to instruction block D-3.

12. CONDUCTING INSTRUCTION ON BLOCK D-3: GAGING TABLES AND VOLUME CORRECTIONS. This instruction block covers the basic steps for gaging storage tanks and volume correction of petroleum products. The student will be taught how to convert the product gage and the bottom sediment and water gage into gallons and how to correct the volume to 60°F.

a. Objectives.

(1) Conditions. The student is placed in the position of a petroleum supply specialist in a petroleum training facility and provided with a strapping chart, volume correction table and a measured liquid depth.

(2) Actions. The student will:

(a) Determine the volume of measured liquid petroleum using a strapping chart.

(b) Provided the appropriate table for an API gravity at 60°F and the observed temperature of a volume of product, locate the conversion factor for volume correction and calculate the product volume at 60°F.

(3) Standard. The student must perform or answer correctly at least 70 percent of performance tasks or written requirements on the performance examination on volume correction (PS-D-3-PFS-E).

b. Logistical Requirements.

(1) Materials. Paper, pencil, Student Guide, strapping chart, volume correction table.

(2) References. TM 10-1101, Petroleum Handling Equipment and Operations.

(3) Setting. Classroom, Petroleum Training Facility.

(4) Allotted Time. 5 hours. (See paragraph 11b(4) for adjustment of time allotment.)

(5) Equipment. Storage tanks.

c. Directions for Carrying Out Instruction. Make sure the steps below are followed during the instruction process.

(1) Step 1. Have the students read and study appropriate materials and tables in TM 10-1101 pertaining to volume correction calculations.

(2) Step 2. Have students read and do QMS 300.505PT.

(3) Step 3. When students have demonstrated to your satisfaction that they are capable of doing gaging and volume correction, have them take the Annex D-3 examination at this time.

(4) Step 4. If the students pass the Annex D-3 examination with 70 percent or higher, let them proceed to instruction block D-5.

13. CONDUCTING INSTRUCTION ON BLOCK D-4: SAMPLING BULK PETROLEUM. This entire block of instruction has been incorporated in instruction block D-2.

14. CONDUCTING INSTRUCTION ON BLOCK D-5: VALVES, PIPES, AND FITTINGS. This instruction block covers the different types of valves, pipes, and fittings used in a petroleum pipeline system and their operation and maintenance.

a. Objectives.

(1) Conditions. The student is placed in the position of a petroleum supply specialist in a petroleum training facility equipped with standard valves, pipes, and fittings used in a pipeline operation.

(2) Actions. The student will:

(a) Identify the use and purpose of different types of valves and fittings used in a petroleum pipeline operation.

(b) Inspect, adjust, lubricate, disassemble, clean, and repack valves in accordance with FM 10-20.

(3) Standard. The student must perform or answer correctly at least 70 percent of performance tasks or written requirements on the performance examination for Annex D (PS-D-11-PFS-E).

b. Logistical Requirements.

(1) Materials. Paper, pencil, Student Guide.

(2) References. FM 10-20, Organizational Maintenance -- Military Petroleum Pipeline Tanks and Related Equipment; TM 5-343, Military Petroleum Pipeline Systems.

(3) Setting. Classroom, Petroleum Training Facility.

(4) Allotted Time. 6 hours. (See paragraph 11b(4) for adjustment to time allotment.)

(5) Equipment. Standard pipeline valves, pipes, and fittings.

c. Directions for Carrying Out Instruction. Make sure the steps below are followed in the instruction process:

(1) Step 1. The students should read and study FM 10-20 and QMS 300.502H-1 pertaining to the operation and maintenance of pipeline valves, pipes, and fittings.

(2) Step 2. Have students do the practical exercises in QMS 300.502H-1.

(3) Step 3. When the students have demonstrated their ability to perform the tasks and written requirements in this instruction block to your satisfaction, let them proceed to instruction block D-6.

15. CONDUCTING INSTRUCTION ON BLOCK D-6: MANIFOLDS. This instruction block deals with the flow of petroleum products into, out of, and through the manifold system of a military pipeline. Procedures for marking and recognizing pipeline markings are also presented.

a. Objectives.

(1) Condition. The student is placed in the position of a petroleum supply specialist in a petroleum training facility equipped with a pipeline manifold system, a drawing with appropriate markings of a tank farm manifold complex, numbers and line markings used to identify the flow of petroleum products.

(2) Actions. The students will:

(a) Identify the different types and purposes of manifolds used by the military.

(b) Identify liquid petroleum pipeline systems by number or color codes.

(c) Perform operator maintenance on manifold systems as prescribed in TM's 5-343 and 10-1118.

(d) Operate liquid petroleum manifold system by transferring product from tank to tank(s).

(3) Standard. The student must perform or answer correctly at least 70 percent of performance tasks or written requirements on the performance examination for Annex D (PS-D-11-PFS-E).

b. Logistical Requirements.

(1) Materials. Paper, pencil, Student Guide.

(2) References. TM 5-343, Military Petroleum Pipeline System; TM 10-1118, Petroleum Terminal and Pipeline Operations.

(3) Setting.. Classroom, Petroleum Training Facility.

(4) Allotted Time. 4 hours. (See paragraph 11b(4) for adjustment of time allotment.)

(5) Equipment. Liquid petroleum manifold system.

c. Directions for Carrying Out Instruction. Make sure the steps below are followed during the instructional process:

(1) Step 1. The students should read and study material in TM's 5-343 and 10-1118 pertaining to liquid petroleum manifold systems.

(2) Step 2. Have students read and do the practical exercises in QMS 300.507H-1.

(3) Step 3. When the students have demonstrated their ability to perform the tasks and answer the written questions in QMS 300.507H-1 to your satisfaction, let them proceed to instruction block D-7.

16. CONDUCTING INSTRUCTION ON BLOCK D-7: TRANSFER PUMP. This instruction block covers the six-inch centrifugal pump (commonly referred to as the "transfer" or "feeder" pump) used at truck and railcar loading facilities, bulk reduction stations, and tank farm complexes. It is also used as a "feeder" pump to pump fuel to pipeline pump stations.

a. Objectives.

(1) Condition. The student is placed in the position of a petroleum supply specialist in a petroleum training facility equipped with a six-inch, single-stage, gasoline-driven, centrifugal pump unit; storage tanks; and given situations requiring the operation of the unit.

(2) Actions. The student will:

(a) Perform safety precaution checks on six-inch pump unit.

(b) Operate the six-inch pump unit according to procedures specified in TM 5-4320-211-12.

(c) Perform operator maintenance on the six-inch, single-stage centrifugal pump unit before, during, and after operations and complete DA Form 2404 (Equipment Inspection and Maintenance Worksheet).

(3) Standard. The student must perform or answer correctly at least 70 percent of performance tasks or written requirements on the performance examination for Annex D (PS-D-11-PFS-E).

b. Logistical Requirements.

(1) Materials. Paper, pencil, Student Guide, DA Form 2404.

(2) References. TM 10-1112, Military Petroleum Pipeline System: Scheduling and Dispatching; TM 10-1118, Petroleum Terminal and Pipeline Operations; TM 5-4320-211-12, Operator and Organizational Maintenance Manual, Centrifugal Pump.

(3) Setting. Classroom, Petroleum Training Facility.

(4) Allotted Time. 6 hours. (See paragraph 11b(4) for adjustment of time allotment.)

(5) Equipment. Six-inch centrifugal pump unit, storage tanks.

c. Directions for Carrying Out Instruction. Make sure the steps below are followed during the instructional process:

(1) Step 1. Have the students read and study paragraph 10, TM 5-4320-211-12, and paragraphs 16 and 17, TM 10-1112, pertaining to the six-inch centrifugal pump.

(2) Step 2. Have the students read and study QMS 300.508PT and answer the questions for Parts I and II.

(3) Step 3. Have the students read and practice the operational procedures given in Part III of QMS 300.508PT.

(4) Step 4. Have students perform the practical exercise in Part IV of QMS 300.508PT. Assign the students into groups of three or more.

(5) Step 5. When you are satisfied that the students have demonstrated sufficient competence in the performance and written requirements contained in QMS 300.508PT let them proceed to instruction block D-8.

17. CONDUCTING INSTRUCTION ON BLOCK D-8: RAIL TANK CAR. This instruction block covers rail tank cars used for transporting bulk petroleum products between points not served by pipeline or water transportation facilities. The correct procedures for loading and unloading rail tank cars are stressed.

a. Objectives.

(1) Condition. The student is placed in the position of a petroleum supply specialist in a petroleum training facility equipped with a rail tank car, loading and unloading equipment, and track line.

(2) Actions. The student will:

(a) Position a rail tank car, including grounding and bonding operations.

(b) Inspect tank car, sample residue innage, and service with appropriate product.

(c) State two methods for loading and unloading rail tank cars.

(d) Load a tank car and perform gaging according to the long-pole and short-pole methods.

(e) Take a sample and temperature reading of tank car product after loading.

b. Logistical Requirements.

(1) Materials. Paper, pencil, Student Guide.

(2) References. FM 10-18, Petroleum Terminal and Pipeline Operations; TM 10-1101, Petroleum Handling Equipment and Operations; TM 10-1118, Petroleum Terminal and Pipeline Operations.

(3) Setting. Classroom, Petroleum Training Facility.

(4) Allotted Time. 7 hours. (See paragraph 11b(4) for adjustment of time allotment.)

(5) Equipment. Rail tank car, loading and unloading equipment, track line, gaging equipment.

c. Directions for Carrying Out Instruction. Make sure the steps below are followed during the instructional process:

(1) Step 1. The students should read and study Chapter 5, TM 10-1118 and paragraphs 91 through 95 of TM 10-1101 pertaining to rail tank car operations.

(2) Step 2. Have the students read and complete the lesson outline of QMS 300.51IH-1, using FM 10-18 as a reference to make notes in their outline.

(3) Step 3. Divide the class into groups and have each group do the practical exercise on loading and unloading a rail tank car.

(4) Step 4. When you are satisfied that the students have demonstrated sufficient competence in performing the practical exercise, let them proceed to instruction block D-9.

18. CONDUCTING INSTRUCTION ON BLOCK D-9: TANK MAINTENANCE. This instruction block normally covers procedures for maintenance and cleaning of bulk storage tanks. Since no self-paced materials are available for this block, there are no performance tasks or written exercises required by the student. However, the instructor has the option of preparing his own materials using the references given below and based on the following objectives:

Objectives.

(1) Condition. The student will be placed in the position of a petroleum supply specialist and provided with a mine safety set, explosimeter, and safety tools as well as AR 420-56, TM's 5-678 and 10-1109.

(2) Actions. The students will:

(a) Fit the safety harness of the mine safety set to their body.

(b) Fit the fresh-air mask of the mine safety set to their face.

(c) State the uses of the explosimeter in detecting flammable vapors.

(d) Operate the explosimeter in inspections of hazardous areas.

(e) Perform external maintenance on petroleum storage tanks and accessories as prescribed in TM's 5-687, 10-1109, and AR 420-56.

(3) Standard. The students must perform or answer correctly at least 70 percent of the performance tasks or written requirements prepared by the instructor. (NOTE: This instruction block will not be included on the checklist examination for Annex D for reasons cited in the introductory paragraph.)

19. CONDUCTING INSTRUCTION ON BLOCK D-10: WATERFRONT OPERATIONS. This instruction block normally covers waterfront terminals and operations. However, since no self-paced materials have been developed for this instruction block, the student will not be tested on this section. If desired, the instructor has the option of teaching the principles of waterfront operations, providing the instruction is based on the objectives given below.

Objectives.

(1) Conditions. The student will be placed in the position of a petroleum supply specialist and situated at a marine terminal equipped to move petroleum from ship to shore and vice versa. The student is also provided with TM's 10-1101, 10-1118, and MF 10-7990.

(2) Actions. The student must:

(a) Connect bonding cable from shore to ship and close grounding switch.

(b) Board a ship and perform gaging operations.

(c) Gage and sample cargo tanks before and after discharge operations.

(d) Couple cargo hose from shore to ship and conduct preoperations check for oil leaks and spills.

(e) Perform cargo discharge operations from ship to base terminal.

(f) Unload ship using available shore-base facility.

(g) Prepare tanker discharge report (DD Form 250-1, Tanker/Barge Material Inspection and Receiving Report).

(h) State three methods for cleaning up oil spills.

(3) Standard. The student must perform or answer correctly at least 70 percent of the performance tasks or written requirements prepared by the instructor. (NOTE: This instruction block will not be included on the checklist examination for Annex D for reasons cited in the introductory paragraph.)

Appendix A

Course Map - Annex D

ANNEX MATERIALS

QMS 300.503H-1 (Nov 76)

QMS 300.503H-1 (Sep 76)

QMS 300.506H-1

QMS 300.503PE-1

QMS 300.505PT

QMS 300.502H-1

QMS 300.507H-1

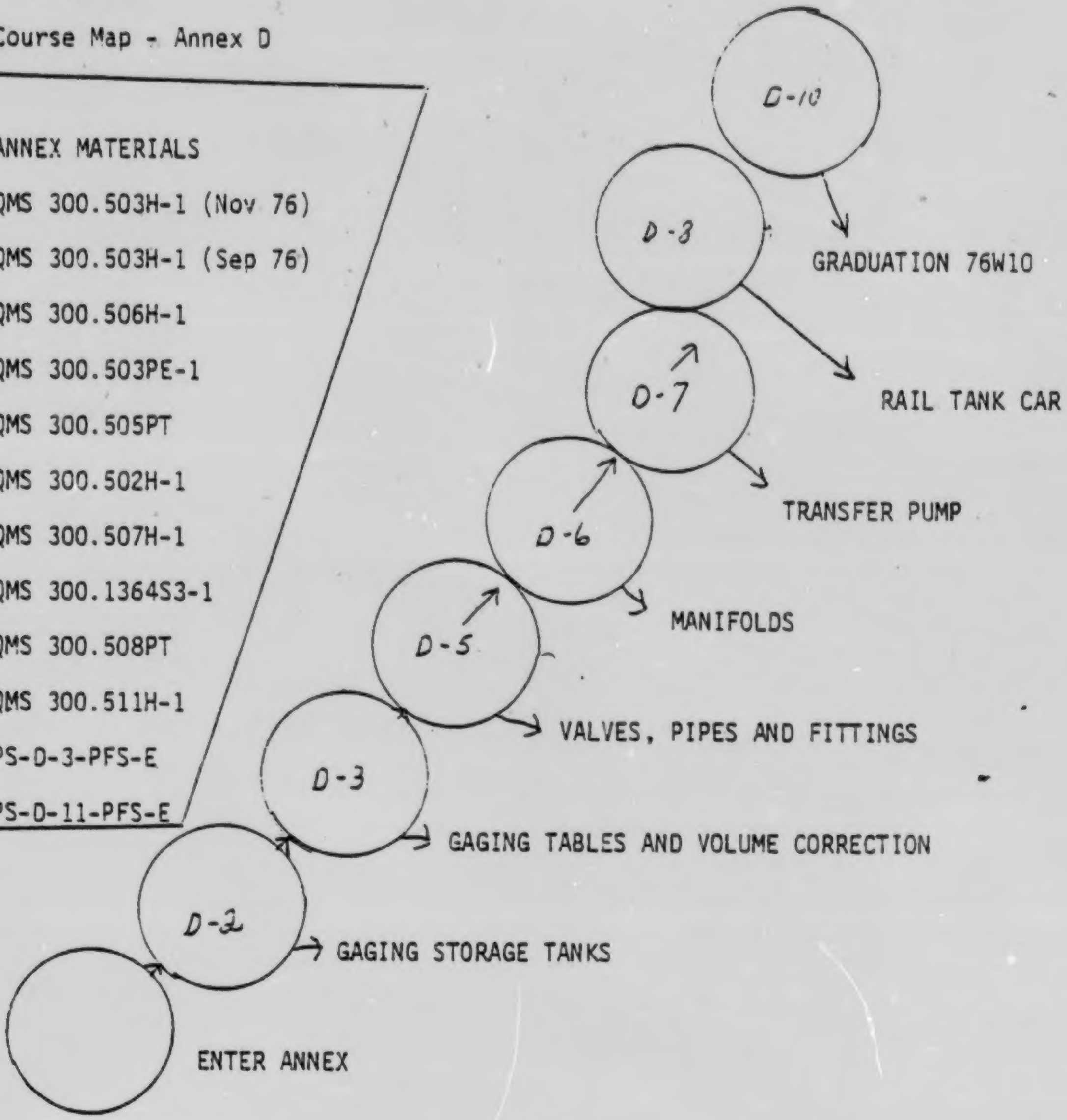
QMS 300.1364S3-1

QMS 300.508PT

QMS 300.511H-1

PS-D-3-PFS-E

PS-D-11-PFS-E


D-10
GRADUATION 76W10
D-8
RAIL TANK CAR
D-7
TRANSFER PUMP
D-6
MANIFOLDS
D-5
VALVES, PIPES AND FITTINGS
D-3
GAGING TABLES AND VOLUME CORRECTION
D-2
GAGING STORAGE TANKS
ENTER ANNEX

APPENDIX B

INSTRUCTOR CONTROL CARD

STUDENT'S NAME______________________ STARTING DATE______________

Block	Action	Successfully Completed	Remarks
D-2	QMS 300.503H-1(Nov76) 300.503H-1(Sep76) 300.506H-1 300.503-PE1		
D-3	QMS 300.505PT Examination		
D-5	QMS 300.502H-1		
D-6	QMS 300.501H-1		
D-7	QMS 300.508PT		
D-8	QMS 300.511H-1		

APPENDIX C

REFERENCES

FM 10-18	Apr 74	Petroleum Terminal and Pipeline Operations
FM 10-20	May 74	Organizational Maintenance -- Military Petroleum Pipeline Tanks and Related Equipment
TM 5-343	Feb 69	Military Petroleum Pipeline Systems
TM 5-4320-211-12	Jan 61	Operator and Organizational Maintenance Manual - Centrifugal Pump
TM 10-1112	Oct 64	Military Petroleum Pipeline System: Scheduling and Dispatching
TM 10-1118	Sep 66	Petroleum Terminal and Pipeline Operations

411

NIPUB 358(SG)D

PETROLEUM SUPPLY SPECIALIST
MOS 76W10

STUDENT GUIDE
Annex D

U.S. ARMY QUARTERMASTER SCHOOL
FORT LEE, VIRGINIA

SUPPLY TRAINING CENTER OF THE ARMY SCHOOL SYSTEM

ATSM-DT-TM-OT-ET
MAY 1978
REPRINT DATE JUNE 1979

Army-Fort Lee, Va.-5288-80-600-C

412

QMS 300.501 H

INTRODUCTION TO
D ANNEX

PROPONENT DEPARTMENT: Petroleum and Field Services

May 1977

THIS SUPERSEDES QMS 300.501 DATED FEBRUARY 1975.

Welcome to Terminal Operations. During this annex you will learn what happens at a petroleum terminal. The three main functions of a terminal are: Receiving, Storage and Issuing bulk petroleum products.

"D" Annex is self-paced. To successfully complete the annex you must read the handouts and follow directions to the letter. As it is throughout the course we are not trying to make experts out of you but you do have to achieve at least a working knowledge of the subject areas. This outline should assist you progressing through "D" Annex successfully.

The first series of booklets you will receive is on gaging and sampling. The first three booklets will be completed in the classroom area. You will also watch two films during this period. Average completion time - five hours. The last booklet in this series is the practical exercise. This will be done in the PTF area. The completion time here varies with the individual. When the instructor is confident that you know the basic principles involved you will be tested.

The next booklet you will receive is on volume correction. Here you will use the information from gaging and determine exactly how much fuel you have at any given temperature. This class deals with mathmatics but you don't have to be a math genius to pass the test. Read the handout, work the problems, and see the film. Average completion time - three hours. Check with the instructor before you take the exam to be sure you understand the basics.

After you have completed the test on volume correction you will receive two more booklets. One on valves, pipes and fittings; and one on manifolds. Read the programs and follow all directions to the letter. Average completion time - two hours.

The PTF portion is done at depot operations. Check in with the instructor and work out practical exercise.* When the instructor is satisfied that you know the subject, you will return to the Control Desk.

*NOTE: During this portion of the lesson you could become part of an operation and actually pump fuel at the depot area.

The last two booklets you will receive are on the 6" single-stage pump, and the rail tank car. You work these basically the same way as the preceding lessons. Average completion time - three hours. When you go to the PTF this time you will be given your final exam when the instructor feels you are ready. You could also become part of an operation during this class. Remember all your safety rules that you learned previously. When you have successfully completed the final exam you are ready for the next annex.

Keep in mind the completion times are average times. You might complete a block of instruction faster or slower than the time listed.

Don't hurry yourself. Make sure you understand what you read. If you have trouble understanding, check with the instructor. That's what he is there for.

Remember, the key word in self-pace is read. All the information you need is right at your fingertips. It is up to you to put it to use.

415

U. S. ARMY QUARTERMASTER SCHOOL

PROGRAMED TEXT

SAMPLING

PROPONENT DEPARTMENT: Petrl & Fld Svcs

June 1977

THIS SUPERSEDES QMS 300.503PT DTD NOV 76.

OBJECTIVES

Upon completion of this programed text and given the appropriate samplers, gages, and tank, the student will be able to:

1. Select the proper apparatus for obtaining a given petroleum sample.
2. Explain the proper procedure for obtaining a given petroleum sample.
3. Perform various sampling operations.

In accordance with TM 10-1105, Chap 7; TM 10-1101, Chap 8 & 12, and TM 10-1167, D270.

STUDENT INSTRUCTIONS

This is a self-teaching programed text. To use this programed text correctly, answer each question in turn and record your answer in the space provided in the programed text. When you have answered a question to your satisfaction, turn the page. At the top of the next page you can compare your answer with the correct answer. If your answer was incorrect, review the preceding pages until you understand how the correct answer was obtained. Then proceed reading the programed text and continue to the next question. All answers to the questions are based on information you will be given in the text. You will not help yourself if you look at the correct answer before you attempt to answer a question. If you do not understand any part of the programed text, consult an instructor.

418

INTRODUCTION

As a Petroleum Supply Specialist you will often be required to take samples of petroleum products in addition to performing laboratory tests on these samples. Sampling petroleum products is an important skill in itself. Knowing how to take a sample is as important as the results obtained from testing that sample. If a sample is not taken properly, no amount of laboratory work will yield accurate, reliable results on the product represented by the sample. The precautions required to assure a representative sample are many and depend on the type of product and type of container being sampled.

427

EXPLANATION

1. Before you learn proper sampling techniques, it is important that you understand exactly what a sample is. A sample is a small part of a quantity of a substance, representative of the entire quantity, used for inspection or to determine the quality of the substance. For example, a one gallon sample of gasoline submitted to a laboratory may represent 40,000 gallons of gasoline in a storage tank. The gallon of gasoline in the sample can must be representative of the 40,000 gallons of gasoline in the tank to yield accurate, reliable laboratory results.

Complete the following statement:

A (1) ______________ is a small part of a quantity of a substance,

(2)____________________ of the entire quantity, used for inspection or to determine the quality of the substance.

Turn to page 3.

(1) sample
(2) representative

2. There are basically six types of samplers used to take samples of different products from various containers. There are the:

a. weighted copper beak

b. drum thief

c. Bacon bomb

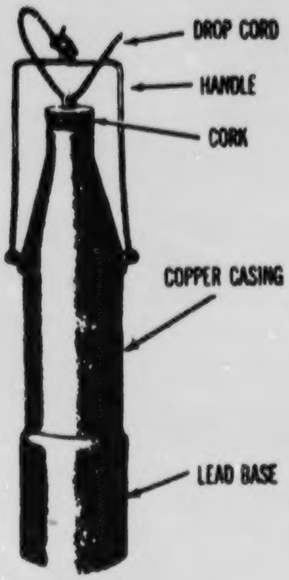
d. weighted bottle

e. Tulsa thief
f. Probe sampler

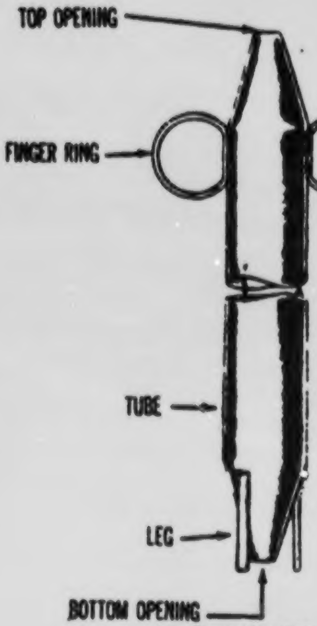
The weighted copper beaker consists of a copper beaker permanently attached to a lead base. A drop cord is attached to a handle through a ring in a stopper so that a short, quick pull on the cord opens the beaker at any desired point beneath the surface of the liquid. The weighted copper beaker is used to take upper, middle, lower, or all-level samples of liquid products of 16 psi or less Reid Vapor Pressure. It is used in tanker or barge compartments, shore tanks, tank cars, and tank trucks. Turn to page 4 for an illustration of a weighted copper beaker. Then turn to page 5.

Answer to Progress Check Question 1

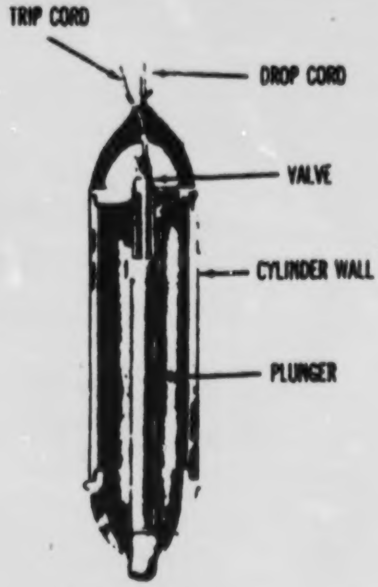
sample - Ref - Page 2


DROP CORD
HANDLE
CORK
COPPER CASING
LEAD BASE

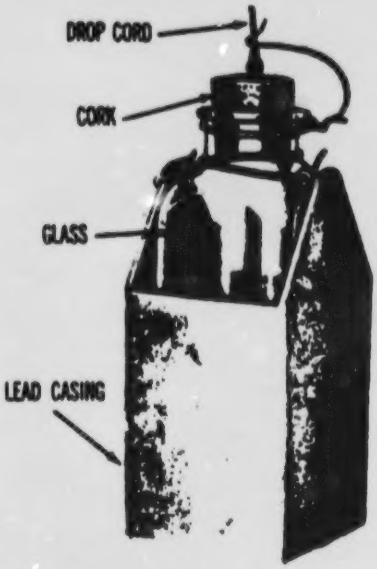
A. WEIGHTED BEAKER


TOP OPENING
FINGER RING
TUBE
LEG
BOTTOM OPENING

B. DRUM THIEF


TRIP CORD
DROP CORD
VALVE
CYLINDER WALL
PLUNGER

C, BACON BOMB


DROP CORD
CORK
GLASS
LEAD CASING

D. WEIGHTED BOTTLE

Complete the following statement:

The (1) ____________ ____________ ______________ consists of a copper bottle permanently attached to a lead base. The weighted copper beaker is used to take (2)____________ ______________ ______________ and ______________ ______________ samples of liquid products of 16 psi or less Reid Vapor Pressure.

3. A drum thief is a plastic cylinder sampler consisting of two piece plastic tube 39 1/2 inches long and 1 1/2 inches at maximum diameter. The tube is fitted with two finger rings at the upper end and three supporting legs at the bottom. Both ends are tapered and have openings. The top openings of the sampler is closed with a thumb until the sampler is submerged in the liquid. Then the thumb is removed from the opening, allowing the liquid to fill the sampler. This sampler is used to take samples of liquid products of 12 psi or less Reid Vapor Pressure and samples of semi-liquid products. It is used to take samples from drums and 5 gallon cans. Turn to page 4 for an illustration of a drum thief. Then turn to page 6.

Answer to Progress Check Question 2

a. weighted copper beaker - Ref page 3
b. drum thief
c. bacon bomb
d. weighted bottle
e. Tulsa thief
f. Probe sampler

423

(1) weighted, copper beaker
(2) upper, middle, lower and all level

Complete the following statement:

A (1) ____________ _______________ is a plastic cylinder consisting of a two piece plastic tube. It is used to take samples from (2) _______________ and 5 gallon ____________.

4. The Bacon bomb is a nickel-plated cylinder which consists of a special metal cylinder tapered at both ends and fitted with an internal, plunger-type valve that opens automatically when the sampler strikes the bottom of a container. A drop cord is attached to a ring at the top of the sampler. A trip cord is attached for the purpose of opening the sampler at any level. The bomb is used most commonly to take bottom samples of liquid products of 2 psi or less Reid vapor pressure and samples of semi-liquid products. It is used in storage tanks and in tank cars. When equipped with a trip cord, this sampler can be used for taking samples at various levels by pulling the trip cord at the desired level. It may not be used for taking all level samples. The Bacon bomb can be modified to provide handling and finger rings and pouring spout for use with the standard can with 1 3/8 inch opening. Turn to page, 4 for an illustration of Bacon bomb, then turn to page 7.

(1) drum thief
(2) drums and 5 gallon cans

Complete the following statement:

The (1) ______________ _________________ is a nickel plated brass cylinder which consists of a special metal cylinder tapered at both ends and fitted with an internal, plunger-type valve. It is most commonly used to take (2)__________________ samples of liquid products of 2 psi or less Reid vapor pressure and samples of semi-liquid products.

5. The weighted bottle sampler consists of a glass bottle within a square weighted metal holder. A drop cord is attached through a ring in a stopper so that a short, quick pull on the cord opens the bottle at any desired point under the surface of the liquid. The weighted bottle has the same application as the weighted copper beaker. Turn to page 4 for an illustration of a weighted bottle sampler, then turn to page 8.

425

(1) Bacon bomb
(2) bottom

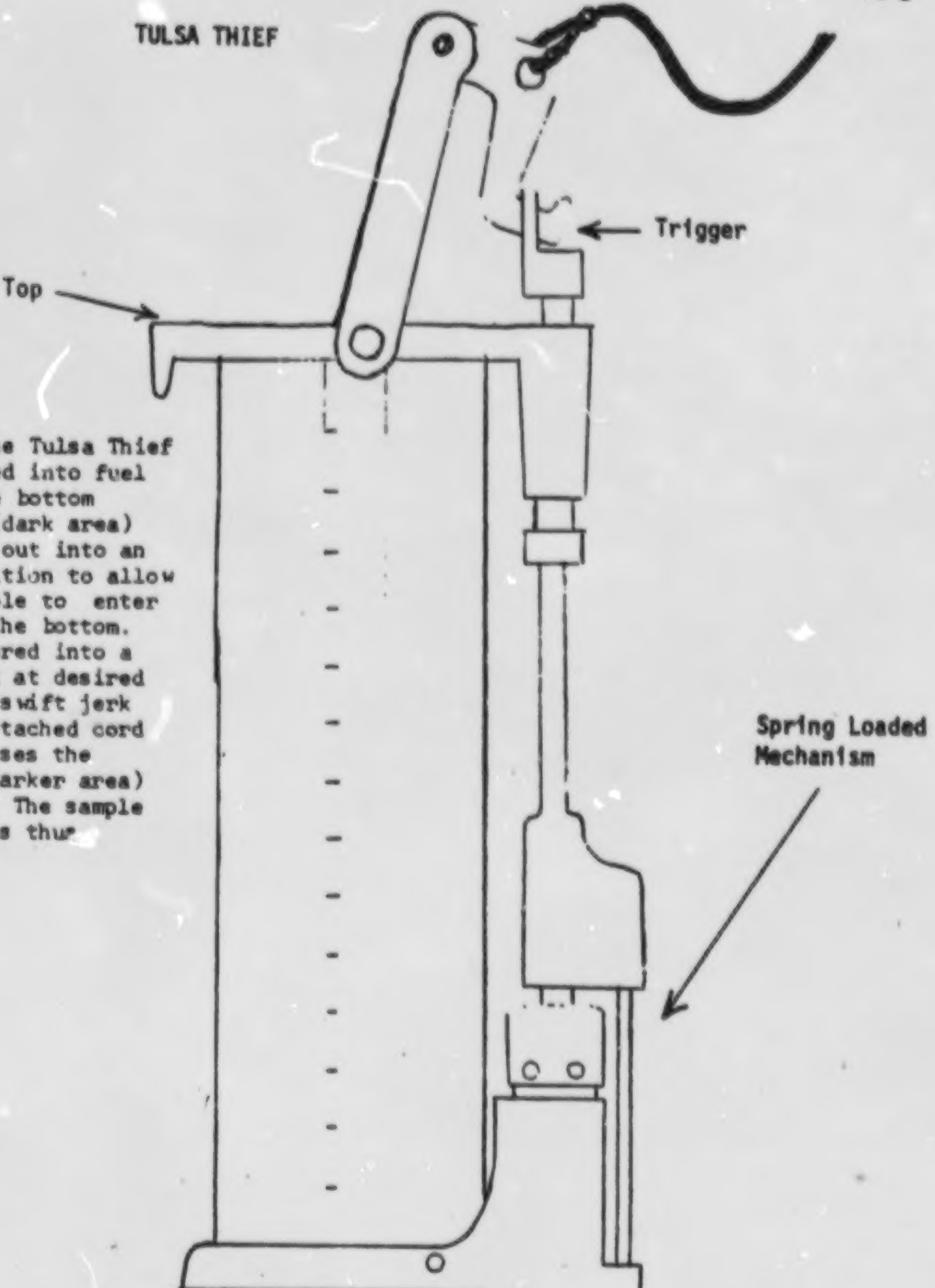
Complete the following statement:

The (1) ________________ bottle consists of a glass bottle within a square weighted metal holder. The weighted bottle has the same application as the (2)_________ ____________ ______________. (Answer on page 10)

6. The Tulsa thief consists of a hollow metal cylinder with a spring activated cover on the bottom of the sampler. The Tulsa thief is equipped with a rope which is used to lower the sampler into a tank and is also used to trigger the cover on the bottom of the sampler. The Tulsa thief is used mainly for taking samples at specific levels although it can be used to take bottom samples. Turn to page 9 for an illustration of a Tulsa thief, then proceed to page 10.

434

TULSA THIEF


Trigger
Top
Spring Loaded Mechanism

Before the Tulsa Thief is lowered into fuel tank, the bottom portion (dark area) is swung out into an open position to allow fuel sample to enter through the bottom. When lowered into a fuel tank at desired level, a swift jerk of the attached cord (top) closes the bottom (darker area) portion. The sample of fuel is thus trapped.

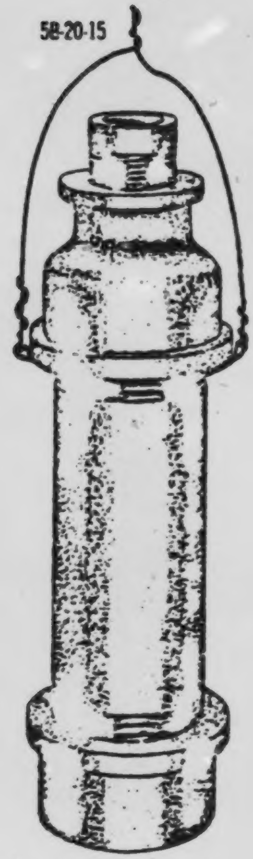
427

(1) weighted
(2) weighted copper beaker

Complete the following statement:

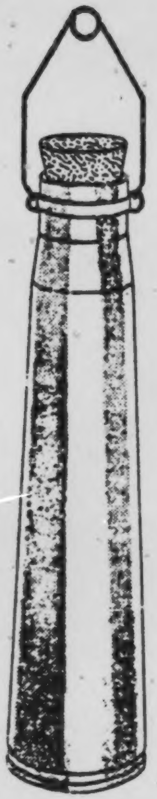
The (1) ____________________ ________________________ consists of a hollow cylinder with a spring activated cover on the bottom of the sampler (answer on page 12).

7. The five samplers mentioned in previous paragraphs are standard and are usually available through supply channels. Conditions may arise, however, where samplers will have to be made or obtained locally. Three types of improvised samplers are shown on page 11. Proceed to page 12.



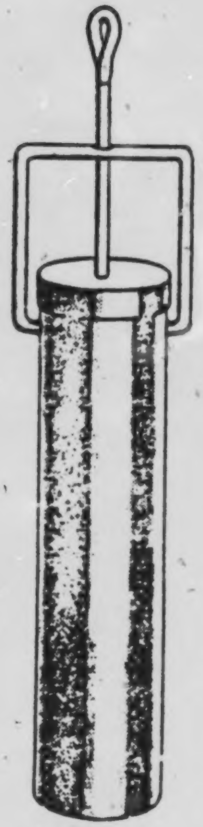
TYPE A

Type A sampler
Improvised sampler assembled from standard size pipe fittings



TYPE B

Type B sampler
Improvised sampler made from a 40-mm shell case



TYPE C

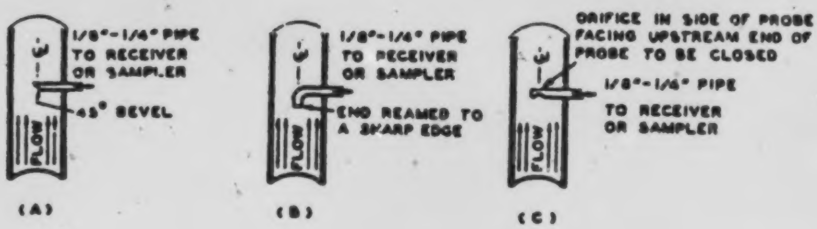
Type C sampler
Improvised sampler made from 1¼-inch metal tubing

429

(1) Tulsa thief

The sixth type of standard sampler is the probe sampler.

8. To collect a continuous sample from a pipeline, filling line, or transfer line; a sampling probe is used. A sampling probe is a tube extending to the center of the pipeline, filling line, or transfer line. The function of the sampling probe is to withdraw from the flow stream a portion that will be representative of the entire stream. The sample is withdrawn manually or by using automatic devices. To insure a representative sample, the sample probe is mounted horizontally in a vertical run of pipe as near as possible to the product receiver. Detailed information on continuous sampling and sample probes can be found in ASTM D-270. Three types of sampling probes are illustrated below.


1/8"-1/4" PIPE
TO RECEIVER
OR SAMPLER
45° BEVEL
FLOW
(A)
1/8"-1/4" PIPE
TO RECEIVER
OR SAMPLER
END REAMED TO
A SHARP EDGE
FLOW
(B)
ORIFICE IN SIDE OF PROBE
FACING UPSTREAM END OF
PROBE TO BE CLOSED
1/8"-1/4" PIPE
TO RECEIVER
OR SAMPLER
FLOW
(C)

Turn to the next page.

438

Review

Match the following samplers with the types of samples they are used to take by placing the corresponding letter of each sample type in the corresponding blank by each type of sampler.

Sampler	Sample Type
_____ weighted copper beaker	a. Samples from drums & 5 gallon cans
_____ drum thief	b. Bottom samples
_____ Bacon bomb	c. Upper, middle, lower & all level samples
_____ weighted bottle	d. Specific level samples & bottom samples
_____ Tulsa thief	e. Continuous sample from pipeline
_____ probe sampler	

Complete the following statement:

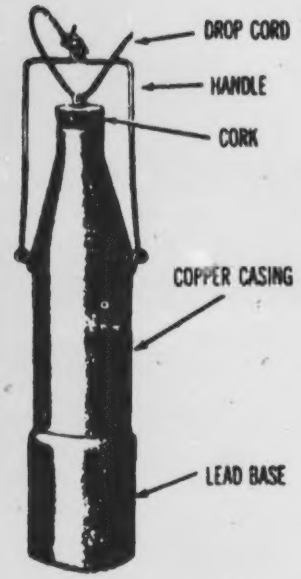
A (1)________________ is a small part of a quantity of a substance,

(2)__________________ of the entire quantity, used for inspection or to

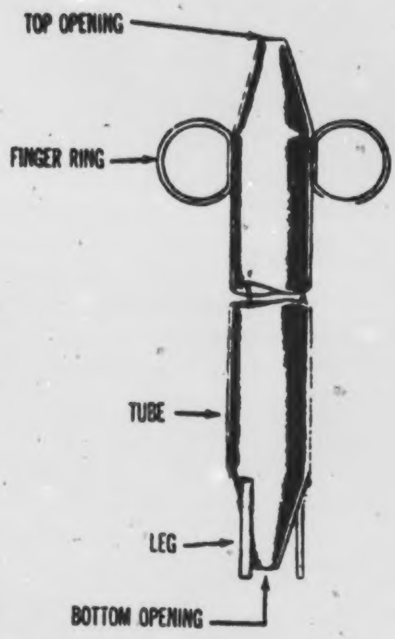
determine the quality of the substance.

On the following page, label the samplers shown. Then turn to page 15 for the correct responses for the matching, completion, and labeling exercises.

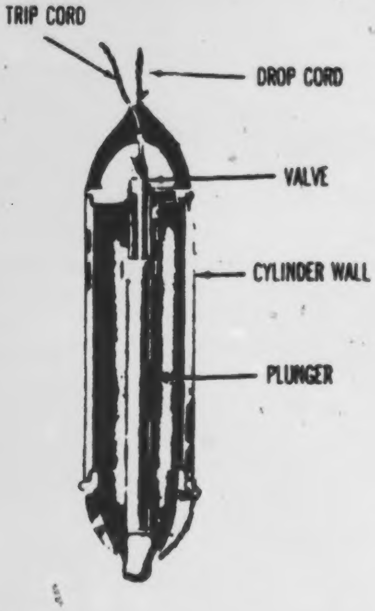
431


DROP CORD
HANDLE
CORK
COPPER CASING
LEAD BASE

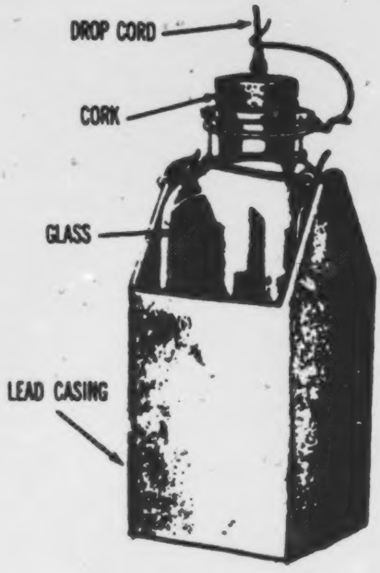
A. ____________________


TOP OPENING
FINGER RING
TUBE
LEG
BOTTOM OPENING

B. ____________________


TRIP CORD
DROP CORD
VALVE
CYLINDER WALL
PLUNGER

C. ____________________


DROP CORD
CORK
GLASS
LEAD CASING

D. ____________________

Match ups

C weighted copper beaker

A drum thief

B Bacon bomb

C weighted bottle

D Tulsa thief

E probe sampler

Completion:

(1) sample
(2) representative

Labeling:

a. Weighted copper beaker

b. Drum thief

c. Bacon bomb

d. Weighted bottle

If you were unable to correctly complete the matching, completion, and labeling exercises, review frames 1 through 8 and try again. If you completed the exercises correctly, proceed to frame 9 on the next page.

9. Various pieces of sampling equipment were reviewed in frame 1 through 8. In the next frames, the various types of samples will be discussed. In review, complete the following statement.

A sample is a (a) ____________ quantity of a substance (b) ______________ of the entire quantity, used for inspection or to determine the quality of the substance. The definitions of various sample types are given below.

Top Sample - A sample taken with a bottle or beaker sampler 6 inches below the surface of a tank's contents.

Upper Sample - A sample taken with a bottle or beaker sampler from the middle of the upper third of a tank's contents.

Middle Sample - A sample taken with a bottle or beaker sampler from the middle of the middle third of a tanks contents.

Lower Sample - A sample taken with a bottle or beaker sampler from the middle of the bottom third of a tanks contents.

Bottom Sample - A sample taken with a bomb sampler from material on the bottom of a tank.

Review the sample types on this page until you are thoroughly familiar with them, then proceed to the next page.

a. small
b. representative

Match the following sample definitions with their corresponding sample term.

Sample

a. Middle sample
b. Lower sample
c. Bottom sample
d. Upper sample
e. Top sample

Sample Definition

_____ 1. A sample taken with a bottle or beaker sampler 6 inches below the surface of a tanks contents.

_____ 2. A sample taken with a bottle or beaker sampler from the middle of the upper third of a tanks contents.

_____ 3. A sample taken with a bottle or beaker sampler from the middle of the middle third of a tanks contents.

_____ 4. A sample taken with a bottle or beaker sampler from the middle of the bottom third of the tanks contents.

_____ 5. A sample taken with a bomb contents sampler from material on the bottom of a tank.

Check your matches on the next page.

_E_ 1.

_D_ 2.

_A_ 3.

_B_ 4.

_C_ 5.

10. Continue your review with these additional sample types.

All level sample - A sample taken by submerging a closed bottle or beaker sampler to a point as near as possible to the tank drawoff level, then opening the sampler and raising it at such a rate that it is about (3/4) three-fourths full when it emerges from the liquid.

Spot Sample - A sample taken at a specific location in a tank.

Composite sample - A sample prepared by combining equal portions of two or more spot samples from a tank.

Single Tank Composite Sample - A sample that is a blend of the upper, middle, and lower samples from a tanks contents.

Multiple Tank Composite Sample - A sample that is a proportional blend of individual all-level samples taken from the compartments of a tanker or barge containing the same product.

Mixed Sample - A sample taken by mixing and stirring the original volume of sample taken and then pouring off the volume desired.

Outlet Sample - A sample taken with a bottle or beaker sampler at the level of a tank outlet, whether fixed or swing line.

Drain Sample - A sample taken from the water drawoff or discharge valve.

Continuous Sample - A sample taken from a flowing pipeline in a manner that the sample is a representative average of the stream during the period of sampling.

After you have thoroughly reviewed the sample definition on this page, turn to the next page.

Match the following sample definitions with their corresponding sample term.

Sample

A. Outlet sample

B. Spot sample

C. Continuous sample

D. Drain sample

E. Multiple tank composite sample

F. Composite sample

G. All level sample

H. Single tank composite sample

I. Mixed sample

Sample Definition

____ 1. A sample taken by submerging a closed bottle or beaker sampler to a point as near as possible to the tank drawoff level, then opening the sampler and raising it as such a rate that it is about three-fourths (3/4) full when it emerges from the liquid.

____ 2. A sample taken at a specific location in a tank.

____ 3. A sample prepared by combining equal portions of two or more spot samples.

____ 4. A sample that is a blend of the "upper, middle, and lower samples from a tanks contents."

____ 5. A sample that is a proportional blend of individual all level samples taken from the compartments of a tanker or barge containing the same product.

____ 6. A sample taken by mixing and stirring the original volume of sample taken and then pouring off the volume desired.

____ 7. A sample taken with a bottle or beaker sampler at the level of a tank outlet, whether fixed or swing line.

____ 8. A sample taken from the water drawoff or discharge level.

____ 9. A sample taken from a flowing pipeline in a manner that the sample is a representative average of the stream during the period of sampling.

When you have completed the matches of this page, check your answers on the following page.

G 1.
B 2.
F 3.

H 4.
E 5.
I 6.

A 7.
D 8.
C 9.

f you did not correctly complete the matching exercises on pages 17 and 19, review frame 9 on page 16 and frame 10 on page 18.

11. Now that you have been exposed to the most common types of samples and sampling equipment, we can turn our attention to sampling operations. A simple set of sampling procedures cannot be given because products are different, the means of product transportation and storage vary, and sampling requirements of many tests are different. Detailed information regarding sampling procedures and techniques can be found in MIL-HDBK-200, latest revision and TM 10-1167, ASTM Manual on Measurement and Sampling of Petroleum and Petroleum Products, Part 18, D-270. However, a few general rules and precautions will be given below.

a. Use approved samplers as specified in ASTM procedures.

b. Make sure that all sampling apparatus and containers are clean, dry and free of lint and fibrous material.

c. Rinse samplers and containers with a portion of the product being sampled to make sure that product is not contaminated with the previous material. Rinse all cans to make sure that any soldering flux is removed, and discard rinsing material.

Complete the following statement:

To make sure that a product is not contaminated with previous material,

(a)______________ samplers and containers with (b)__________________.

Turn to page 21

(a) rinse
(b) a portion of the product being sampled

d. Clean sampling apparatus immediately after use and store in such a way that it will remain clean until its next use.

e. Before taking a continuous sample, draw enough product through sample connections to displace all produce in sample lines and fittings.

f. Do not take samples through storage tanks clean out lines, water drawoffs, bleeder valves, or hoses because such samples will not be representative of the product in the tank.

g. Sample product in drums and like containers by using a thief, not tilting container and using a funnel. Remove all foreign matter from area near closure before removing plug. To thoroughly mix the contents of a drum before sampling, roll the drum on its side for a distance of at least 100 feet.

h. Do not fill any sample container above 90 percent of its capacity. If a container is filled to capacity it may leak due to pressure caused by thermal expansion of the product.

i. Close all sample containers tightly immediately after they are filled. Do not use sealing wax, paraffin, rubber gaskets, pressure sensitive tape or similar materials to seal containers.

j. Crate fragile sample containers well enough to withstand shipment.

Complete the following statement:

To mix thoroughly the contents of a drum before sampling, roll the drum on it side for a distance of at least (a) __________ feet. Do not fill any sample container above (b) __________ percent of its capacity.

Turn to page 22

(a) 100
(b) 90

k. Protect samples of gasoline, jet fuel and kerosene from direct sunlight and contamination by using clean, dry cans or brown bottles. Some of these products will change color rapidly and gum will increase and stability will decrease after short exposure to sunlight.

l. Handle carefully all samples of gasoline and jet fuel that require the vapor pressure test and if possible, cool samples to prevent loss of volatile materials. When possible, maintain liquid fuel samples at a temperature between 30° and 40°F to help preserve product characteristics.

m. Use glass bottles to collect samples of aviation fuel submitted specifically for water and sediment determination. Brown glass bottles or wrapped or covered clean glass bottles should be used to prevent lead precipitation caused by exposure of sample to light. Where transportation of flammable liquids to a laboratory in glass bottles is restricted by law or regulations, metal containers must be used. Before using such containers rinse them thoroughly with the product being sampled. When samples are taken for the millipore test, the sample containers are not rinsed with product. The sample containers are opened, filled, and capped as soon as possible.

n. When samples are taken from a tank truck, the entire contents of the tank should be circulated before sampling.

By following these procedures in your sampling operations you will obtain samples which are truly representative of the product being sampled.

Complete the following statements:

1. When possible, liquid fuel samples should be maintained at (a)__________ to (b)__________ °F to help preserve product characteristics.

2. (c) __________ bottles are used to collect samples of aviation fuel submitted specifically for water and sediment determination.

Turn to page 23

(a) 30
(b) 40
(c) glass

12. Taking samples without knowing what quantity to take is pointless. The normal size of liquid samples is 2 gallons; of semisolids, 5 pounds. The size of special samples for liquid products should be at least 5 gallons unless otherwise specified. When jet fuels are to be tested for thermal stability, 10 gallon samples should be submitted.

Complete the following statement:

The normal size of a liquid sample is (a)______________ gallons. For
number
semisolids, the normal sample size is (b)__________ pounds. Special samples
number
for liquid products should be at least (c)___________ gallons unless otherwise
number
specified. (d) __________ gallons of sample should be submitted when the
number
thermal stability test is to be performed on a jet fuel.

Turn to page 24.

(a) 2
(b) 5
(c) 5
(d) 10

13. Packaged petroleum products require special sampling procedures. These procedures vary widely according to the type of product being sampled. Detailed information regarding sampling procedures of packaged petroleum products can be found in TM 10-1167, D-270.

Proceed to the next page.

Answer to Progress Check Question 3

a. 5
b. 2
c. 5 Ref - page 23
d. 10

14. Each sample submitted to a petroleum laboratory for analysis should be accompanied by a properly completed sample tag, DA Form 1804. This form is illustrated on page 26. The following information is included on the sample tag, DA Form 1804.

a. Product

b. Unit or installation submitting sample

c. Sample number

d. Laboratory number

e. Specification number

f. Amount product sample represents

g. Product manufacturer

h. Sample source

i. person who took sample

j. Stock number

k. Qualification number

l. Fill date

m. Contract bulletin number

n. Armed services procurement number

o. Date sampled

p. Batch number

q. Shipment delivery date.

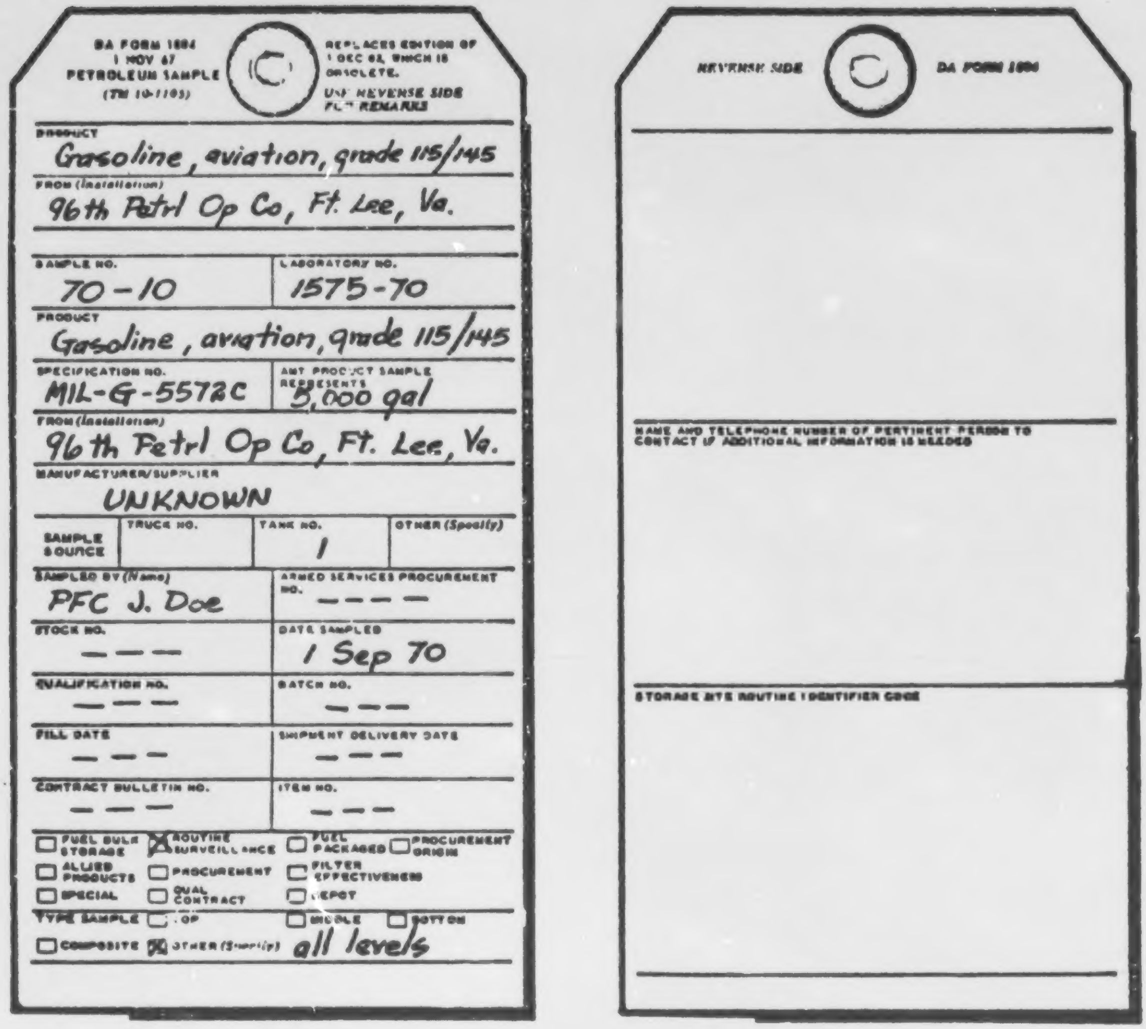
r. Item number

s. Type of sample

t. Reason for sampling

u. Source of additional information

After reviewing the illustration on page 26, turn to page 27.



DA FORM 1804
1 NOV 67
PETROLEUM SAMPLE
(TM 10-1105)

REPLACES EDITION OF 1 DEC 62, WHICH IS OBSOLETE.
USE REVERSE SIDE FOR REMARKS

PRODUCT: Gasoline, aviation, grade 115/145
FROM (Installation): 96th Petrl Op Co, Ft. Lee, Va.

SAMPLE NO. 70-10	LABORATORY NO. 1575-70

PRODUCT: Gasoline, aviation, grade 115/145

SPECIFICATION NO. MIL-G-5572C	AMT PRODUCT SAMPLE REPRESENTS 5,000 gal

FROM (Installation): 96th Petrl Op Co, Ft. Lee, Va.
MANUFACTURER/SUPPLIER: UNKNOWN

SAMPLE SOURCE	TRUCK NO.	TANK NO. 1	OTHER (Specify)

SAMPLED BY (Name) PFC J. Doe	ARMED SERVICES PROCUREMENT NO. — — — —
STOCK NO. — — —	DATE SAMPLED 1 Sep 70
QUALIFICATION NO. — — —	BATCH NO. — — —
FILL DATE — — —	SHIPMENT DELIVERY DATE — — —
CONTRACT BULLETIN NO. — — —	ITEM NO. — — —

☐ FUEL BULK STORAGE ☒ ROUTINE SURVEILLANCE ☐ FUEL PACKAGED ☐ PROCUREMENT ORIGIN
☐ ALLIED PRODUCTS ☐ PROCUREMENT ☐ FILTER EFFECTIVENESS
☐ SPECIAL ☐ QUAL CONTRACT ☐ DEPOT

TYPE SAMPLE ☐ TOP ☐ MIDDLE ☐ BOTTOM
☐ COMPOSITE ☒ OTHER (Specify) all levels

REVERSE SIDE DA FORM 1804

NAME AND TELEPHONE NUMBER OF PERTINENT PERSON TO CONTACT IF ADDITIONAL INFORMATION IS NEEDED

STORAGE SITE ROUTINE IDENTIFIER CODE

DA Form 1804 (Petroleum Sample).

PROGRESS CHECK

The progress check below will give you a chance to determine how much you have learned about sampling petroleum products. After you complete the progress check turn to the pages indicated to check your answer.

Complete the following statements: **Page No**

1. A ______________ is a small part of a quantity of a substance, representative of the entire quantity, used for inspection or to determine the quality of the substance. 3

2. List the six types of standard samples discussed in this text: 5

   a. ______________________

   b. ______________________

   c. ______________________

   d. ______________________

   e. ______________________

   f. ______________________

Complete the following statement:

3. For semisolids, the normal sample size is (a)____________ pounds. 24

The normal size sample for liquid products is (b)__________ gallons.

Special samples for liquid products should be at least (c)__________

gallons unless otherwise specified. When the thermal stability test is

to be performed on a jet fuel (d) ____________ gallons of sample

should be submitted.

If you correctly completed the progress check you are ready to begin Volume II on Gaging Petroleum Products. If you had any difficulty correctly completing the progress check, review the entire text until you can do so.

445

QMS 300.503 H-1

U. S. ARMY QUARTERMASTER SCHOOL

GAGING STORAGE TANKS BY INNAGE METHODS
AND
TAKING PRODUCT TEMPERATURE AT THE PROPER DEPTH

PROPONENT DEPARTMENT: Petroleum and Field Services

November 1976

SUPERSEDES: QMS 300.503 H-1 Dated August 1976

FORWARD

As a Petroleum Supply Specialist you may be required to find the number of gallons in a storage tank. For example, if you are expecting a shipment you will want to find out how many more gallons of product the tank will hold; or if you are planning to issue some of the product contained in a storage tank, you will want to find out how many gallons of "good" product you can issue. To find out how much good product you can issue, you will have to know how much of the liquid is product and how much is sediment and water in the bottom of the tank. At all times, you must keep accurate records of receipt, storage, issue, and shipment of products.

The first step in finding out how many gallons of product you have in a tank is to "gage" the tank. Gaging means to find out the depth of liquid in a tank and to find out what part of the liquid is bottom sediment and water. You also have to take the temperature of the product at the time of gaging.

Your gaging measurements will be in feet and inches; so you will have to convert the measurements into gallons. Because liquid petroleum products expand, or swell, when the temperature goes up and contract, or shrink, when the temperature goes down, you will have to make allowances for changes in temperature when you compute the number of gallons of product in a storage tank. In this two-part program, you will learn how to do all of these things.

447

Sequence A contains the procedure for gaging a tank by the innage method. (NOTE: There is also an outage method of gaging; however, because this method is used infrequently, we are not concerned with it in this text.) Sequence B contains the procedure for taking the product temperature at the time of gaging.

Sequences C and D contains instructions for doing all of the paperwork you will have to do to find out how much product is in the tank. You will learn how to find out how to find out how many gallons of liquid were in the tank at the time of gaging and how much of the liquid was water and how much was good product. You will also learn how to make allowances for changes in temperature by computing the net volume of product corrected to 60°F. (This is a standard used throughout the petroleum industry.)

456

SEQUENCE A

GAGING STORAGE TANK BY INNAGE METHOD

INTRODUCTION

In this sequence you are going to learn the steps in measuring the depth of liquid and the depth of bottom sediment and water in a petroleum storage tank by the innage method. After you have completed this part of the program, you will have a practical exercise in gaging a tank by the innage method, following the procedures you will learn here.

OBJECTIVES

1. Using a petroleum storage tank, you will be able to identify the following terms in accordance with TM 10-1101.

   - Reference point
   - Reference height
   - Datum plate
   - Innage
   - BS&W
   - Product cut (innage method of gaging)
   - Water cut

2. Given two tapes and two bobs, you will be able to select the innage tape and the innage bob in accordance with TM 10-1101.

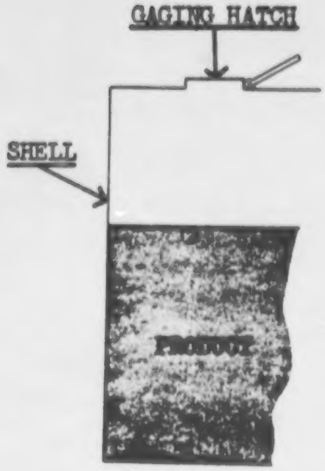
3. Using a petroleum storage tank and all necessary gaging equipment you will be able to gage a tank to within an accuracy of 1/8" as prescribed in TM 10-1101.

449

This is a drawing of a petroleum storage tank.

The wall of the tank is called the shell. There is an opening at the top of the tank which is called the

________________ ______________.



When you measure the product in a storage tank, you will use a tape and bob. If you are measuring the product by the innage method, you will use an innage tape and bob. You will lower the tape and bob into the tank through the

________________ ______________.

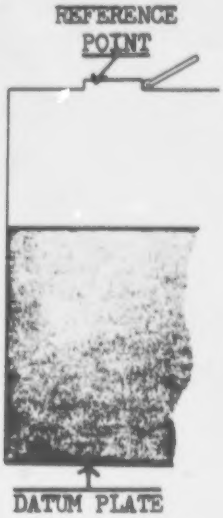
458

gaging hatch

gaging hatch

The reference point is a fixed point at or near the top of the tank from which measurements are made. Sometimes the reference point is a narrow groove cut on the inside of the gaging hatch; sometimes it is a small fixed plate inside the hatch. Directly beneath the reference point, on the bottom of the tank, is a small metal plate called the

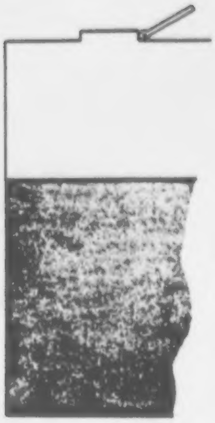
_____________ _____________.



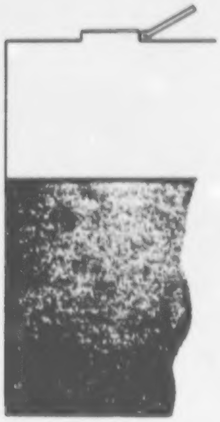
datum plate

It is important for you to remember where the reference point is and where the datum plate is. We will refer to these two terms many times when we start discussing the steps in gaging a tank by the innage method.

Draw an arrow to the reference point.

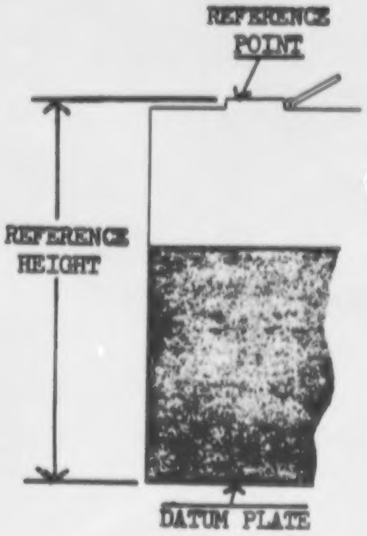


Draw an arrow to the datum plate.



CHECK YOUR ANSWERS ON THE DRAWING BELOW.

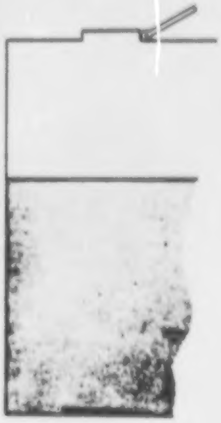
The **reference height** is the distance from the reference ______________ to the bottom of the tank. Although you will have to know the reference height of a tank before you can gage the tank properly, you will not have to memorize the reference height of every tank you gage. The reference height is either stamped on the fixed plate inside the gaging hatch or stenciled on the tank roof near the gaging hatch.



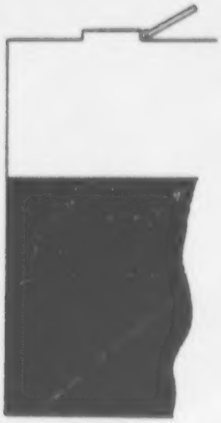
453

point

It is important for you to remember what the term "reference height" means. It is also important for you to know where you should look to find the reference height of the tank you are gaging.

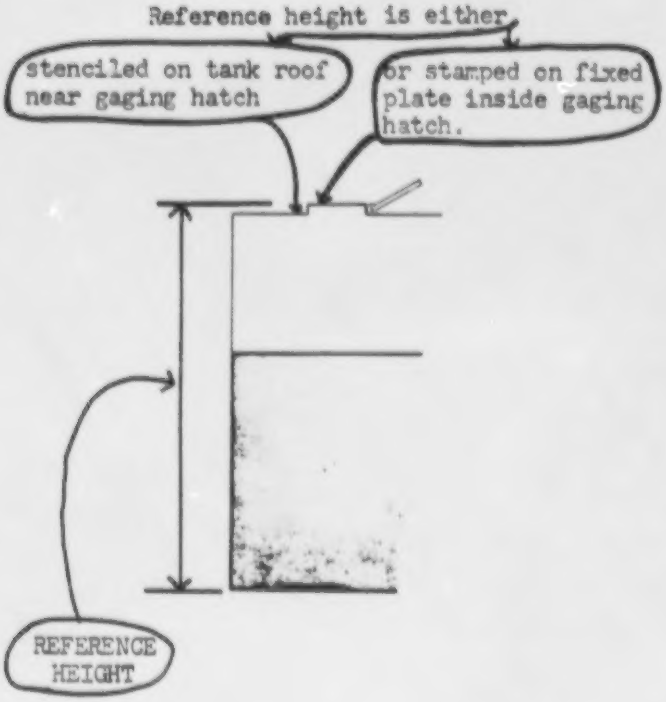


Draw lines to show the reference height of the tank.



Draw arrows to show where you would look to find the reference height of the tank.

462


Reference height is either
stenciled on tank roof near gaging hatch
or stamped on fixed plate inside gaging hatch.
REFERENCE HEIGHT

There are other gaging terms you will have to learn, but we'll take them up as we come to them. Before we go on to the description of the innage tape and bob, let's review what we've covered so far.

Turn the page.

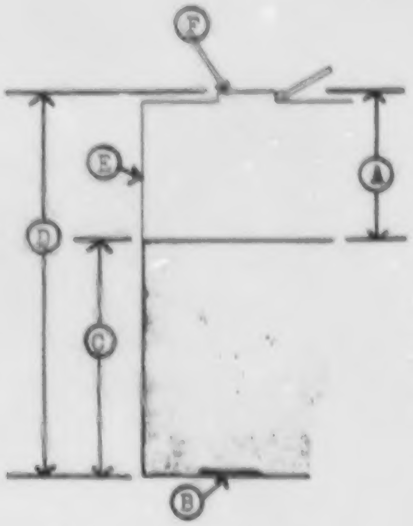
455

See if you can identify, without looking back, the reference point, the reference height, and the datum plate on the drawing. Write the proper letter in the blank beside the term.

Reference point ________

Reference height ________

Datum plate ________



464

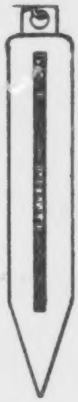
Reference point - F

Reference height - D

Datum plate - B

The first step in gaging a storage tank by the innage method is to select an innage tape and bob.

This is a drawing of an innage bob. The body of the bob is rounded and the bob is pointed at the ____________.
(top or bottom?)



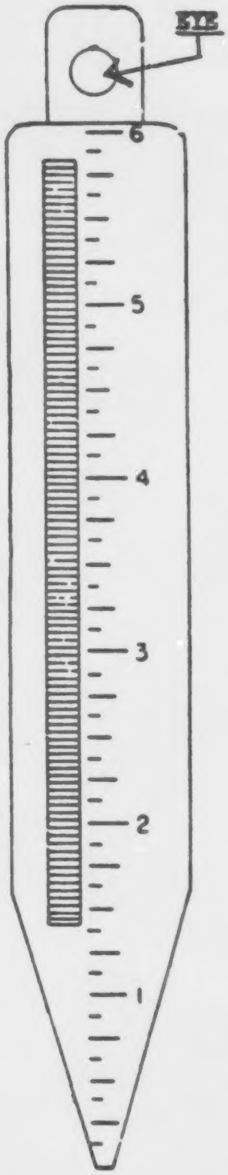
457

bottom

You will be able to recognize an innage bob if you remember that the body of the bob is rounded and that the bottom of the bob is

____________________.

The innage bob is 6 inches long. The inch scale on the bob is divided into 1/8-inch divisions. The zero point of the scale is at the ____________________.
(top or bottom?)

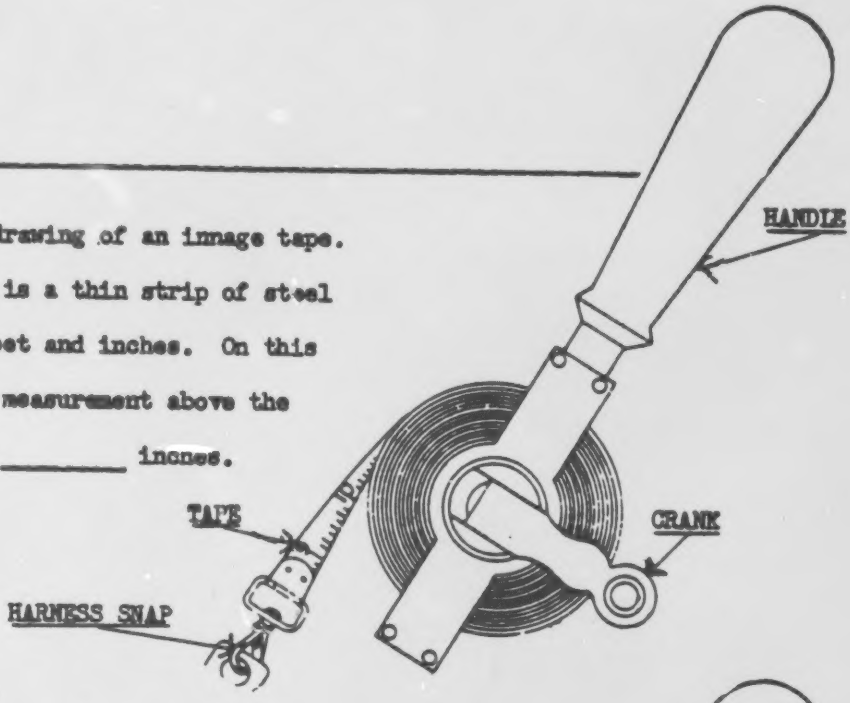


466

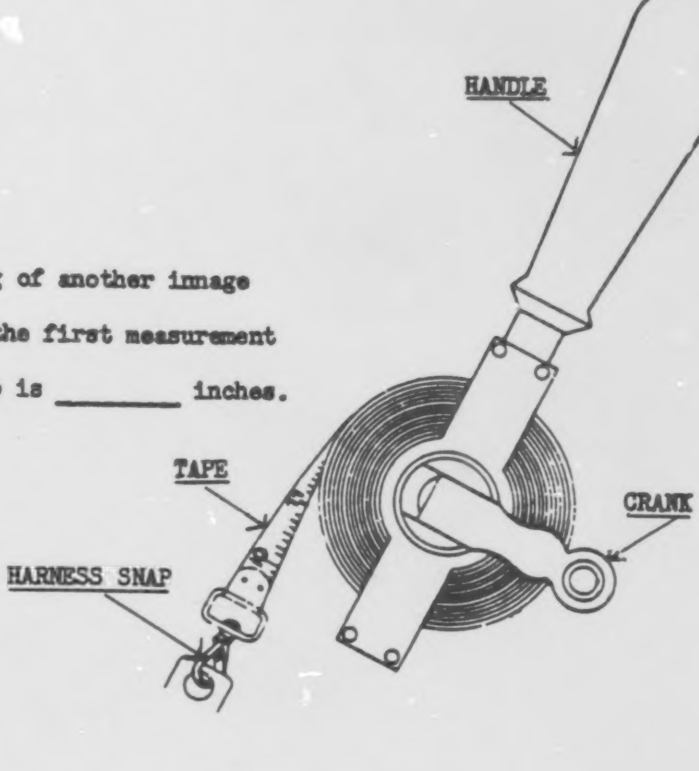
pointed

bottom

This is a drawing of an innage tape. The tape itself is a thin strip of steel marked off in feet and inches. On this tape, the first measurement above the harness snap is ________ incnes.


HANDLE
TAPE
CRANK
HARNESS SNAP
10

This is a drawing of another innage tape. On this tape, the first measurement above the harness snap is ________ inches.


HANDLE
TAPE
CRANK
HARNESS SNAP

459

9

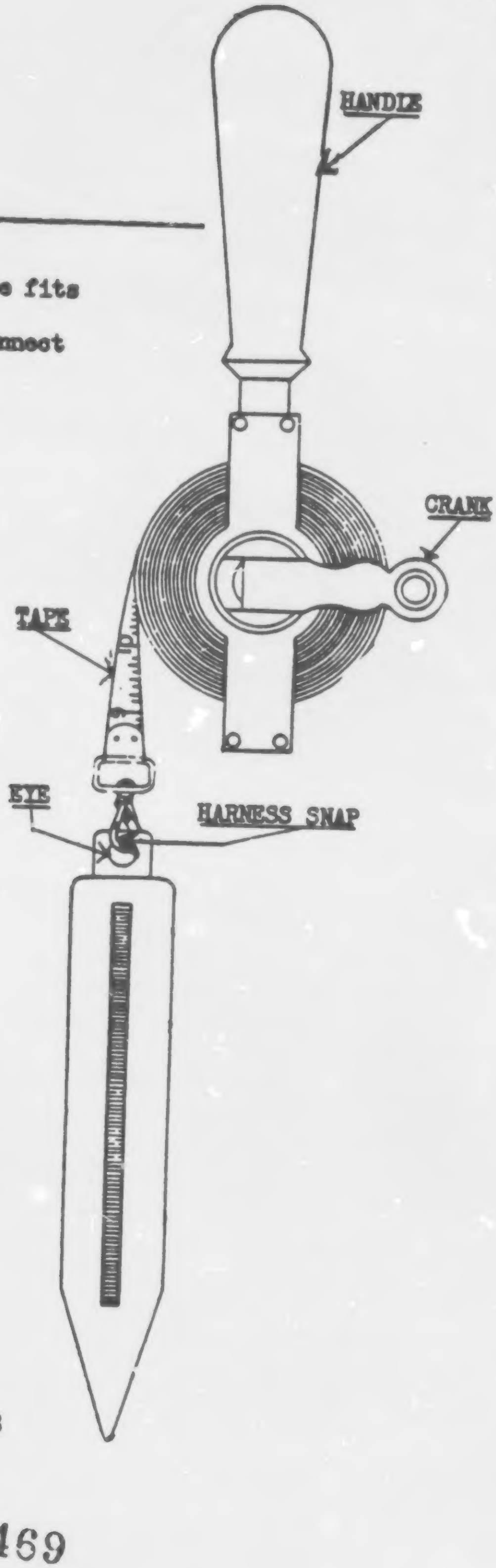
10

You can recognize an image tape if you remember that the first measurement above the harness snap is either ____________________ or ________________________.

9 inches

10 inches

The harness snap on the tape fits through the eye of the bob to connect the __________ and ________.


HANDLE
CRANK
TAPE
EYE
HARNESS SNAP

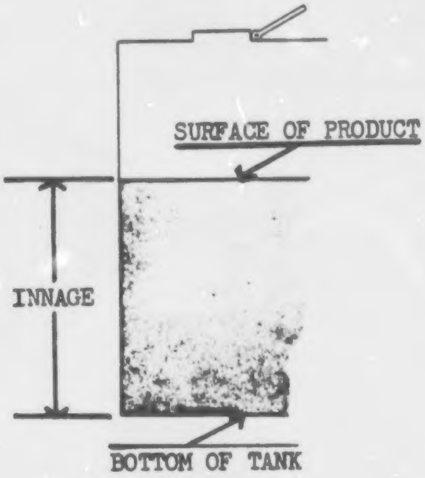
461

tape

bob

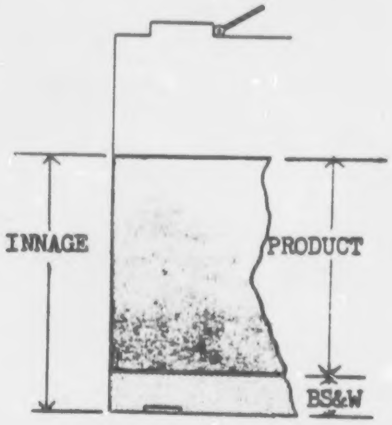
Innage is the depth of liquid in a tank. Therefore, if you are going to measure the depth of liquid in a tank, you are going to measure the distance from the surface of the product to the

____________________ of the tank.


SURFACE OF PRODUCT
INNAGE
BOTTOM OF TANK

470

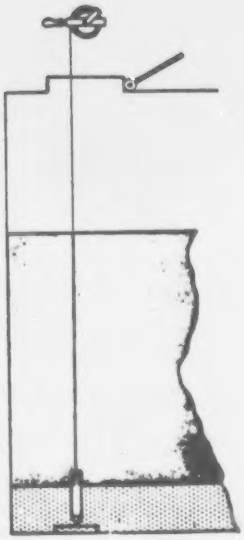
You will notice that we have said that innage is the depth of liquid in a tank, instead of the depth of product. This is because there may be sediment and water in the bottom of the tank, and innage includes both product and bottom sediment and water. We refer to bottom sediment and water as BS&W.



463

When you gage a tank by the innage method, you must measure the distance from the surface of the product to the bottom of the tank to find out the depth of

_______________ in the tank.



Which reading will give you this distance? (Check one.)

Tape reading _______

Bob reading _______

You must also find out the depth of BS&W in the bottom of the tank. Which reading will tell you this? (Check one.)

Tape reading _______

Bob reading _______

472

liquid

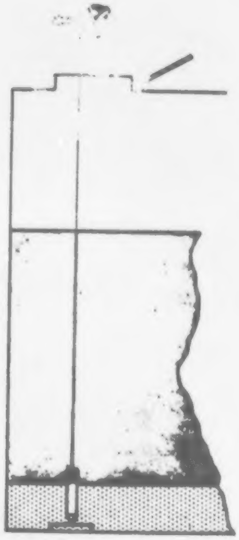
Tape reading

Bob reading

You can measure the depth of

______________ and the depth of

__________ at the same time.

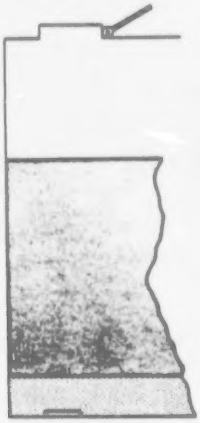


465

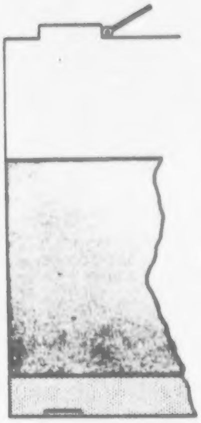
liquid

BS&W

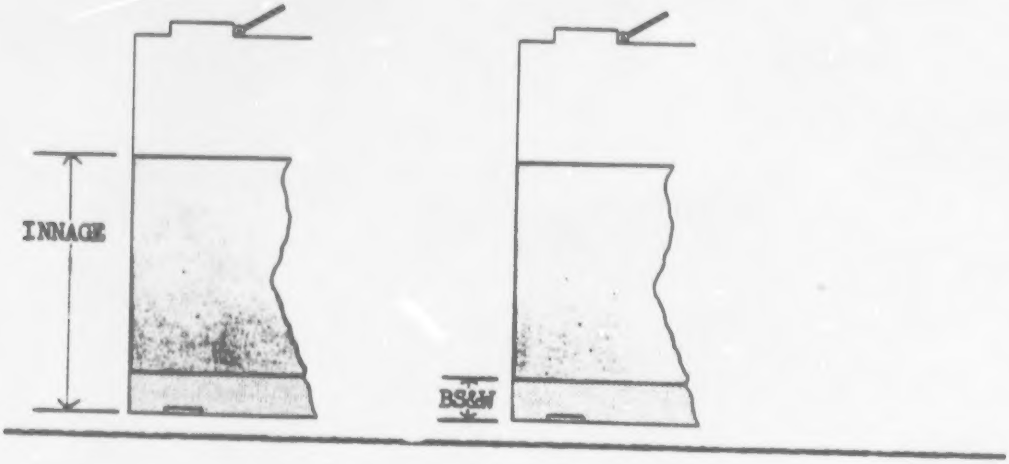
Draw lines to show the innage.



Draw lines to show the BS&W.



474

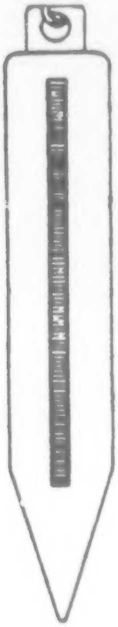


TURN TO PAGE 20.

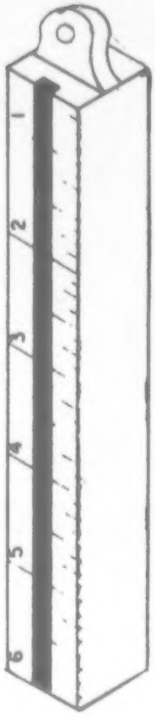
467

Before you start to gage a tank by the innage method, you must select an innage tape and bob.

Which bob is an innage bob? A _________ B _________
(Put a checkmark beside your answer.)



Ⓐ

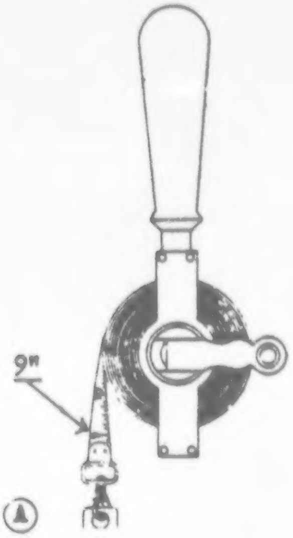


Ⓑ

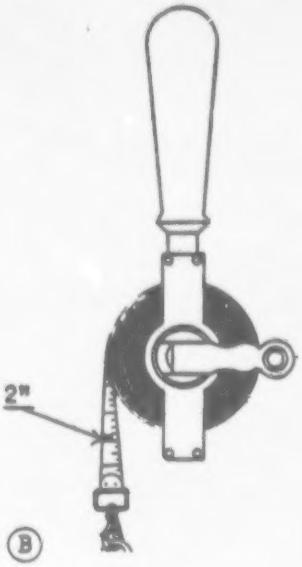
A

Which tape is an innage tape? A ________ B ________

(Put a checkmark beside your answer.)



Ⓐ



Ⓑ

469

A

In addition to an innage tape and bob, you will need a gager's worksheet on which to record your measurements.

You should write the kind of product (kerosene, motor gasoline, etc.) contained in the tank and the size of the tank (500-barrel, 3,000-barrel, etc.) on the gager's worksheet.

You will also need some gasoline-finding paste and some water-finding paste.

Gasoline-finding paste is blue.

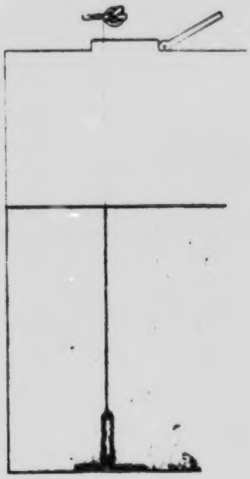
Water-finding paste is pink.

When exposed to any liquid petroleum product for as long as 1 minute, gasoline-finding paste will change color, thus making it easier to read your innage measurement.

Where will you use the gasoline-finding paste? (Check one.)

On the tape. ________

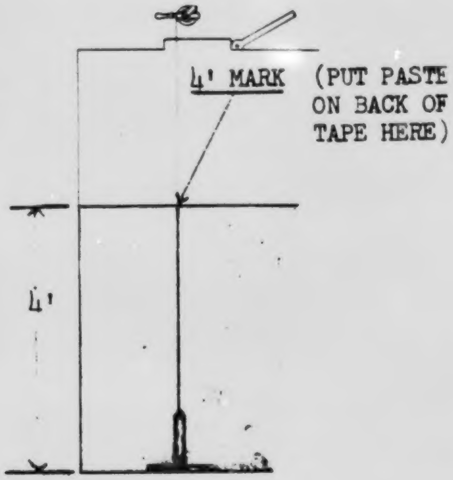
On the bob. ________



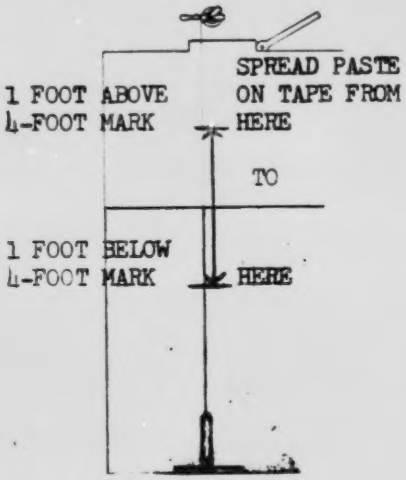
On the tape.

Only a thin coat of paste over a 2-foot length of tape is required.

If you know the approximate depth of the liquid in the tank, you can decide on which part of the tape to put the paste. For example, if the depth of liquid is approximately 4 feet, you should reel out the tape and put a thin coat of paste on the back of the tape (the smooth side) at the 4-foot mark.

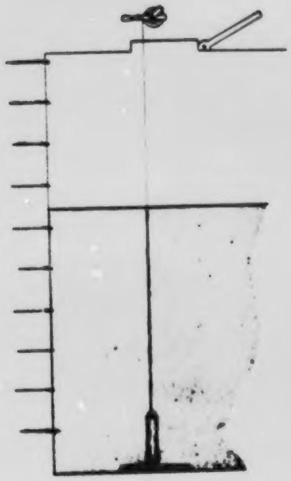

4' MARK
(PUT PASTE ON BACK OF TAPE HERE)
4'

Then you should spread the paste over the back of the tape to a point 1 foot below the mark and to a point 1 foot above the mark.

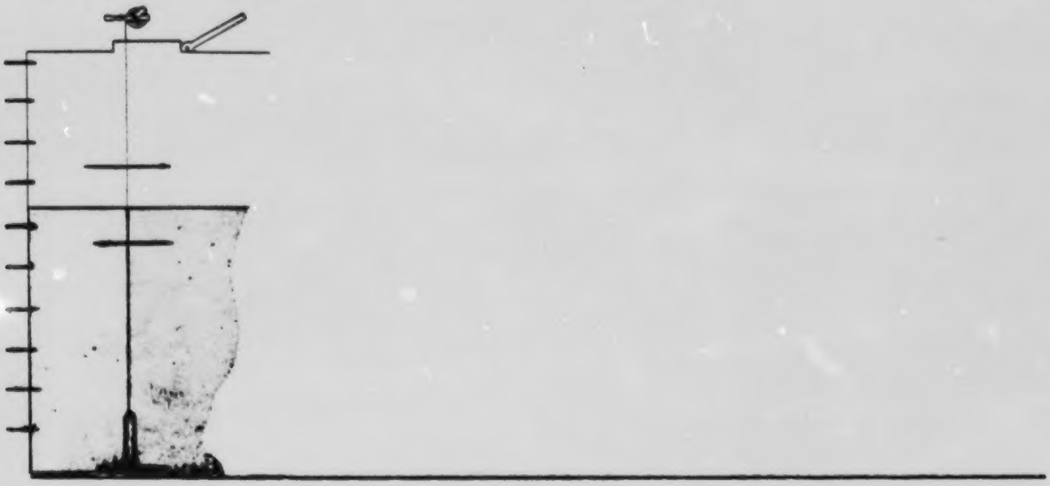

1 FOOT ABOVE 4-FOOT MARK
SPREAD PASTE ON TAPE FROM HERE
TO
1 FOOT BELOW 4-FOOT MARK
HERE

(Note. When you have your practical exercise in gaging by the innage method after you complete this text, your instructor will tell you the approximate depth of the liquid in the tank. When you are in the field, you can refer to your records and find out what the depth of liquid was the last time the tank was gaged.)

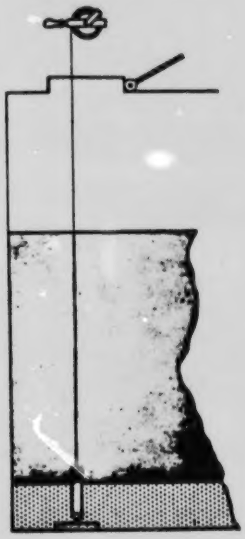
Each of the marks on the side of the tank represents 1 foot. Draw lines on the tape to show the area over which you would spread the gasoline-finding paste.



473



When exposed to water for as long as 1 minute, water-finding paste will change color, thus making it easier to read you BS&W measurement.



Where will you use the water-finding paste? (Check one.)

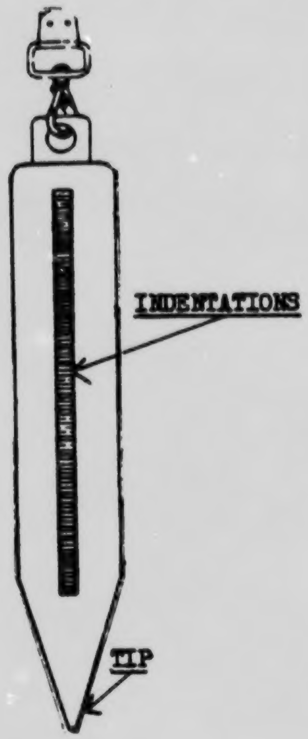
On the tape. ________

On the bob. ________

432

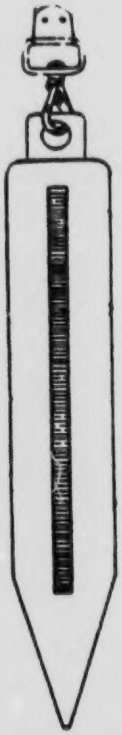
On the bob.

You need only a thin coat of water-finding paste on the bob. You spread a strip of paste down the bob from the top to the tip. Put the paste close to, but not over, the indentations. It is not necessary to cover the entire bob.

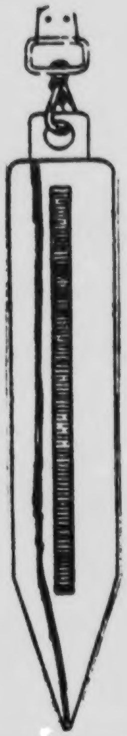


475

Show on the drawing where you would put the paste.



484



NOTE. PASTE CAN BE PUT ON EITHER SIDE OF INDENTATIONS.

After you have put gasoline-finding paste on the ____________ (tape or bob?) and water-finding paste on the ____________ (tape or bob?), you are ready to lower the tape and bob into the tank to measure the depth of ____________________ and the depth of ___________.

477

tape

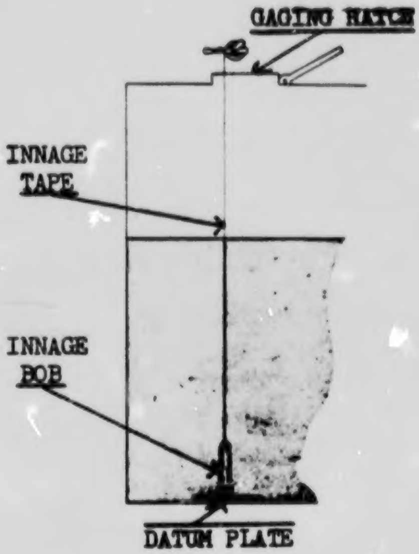
bob

liquid

BS&W

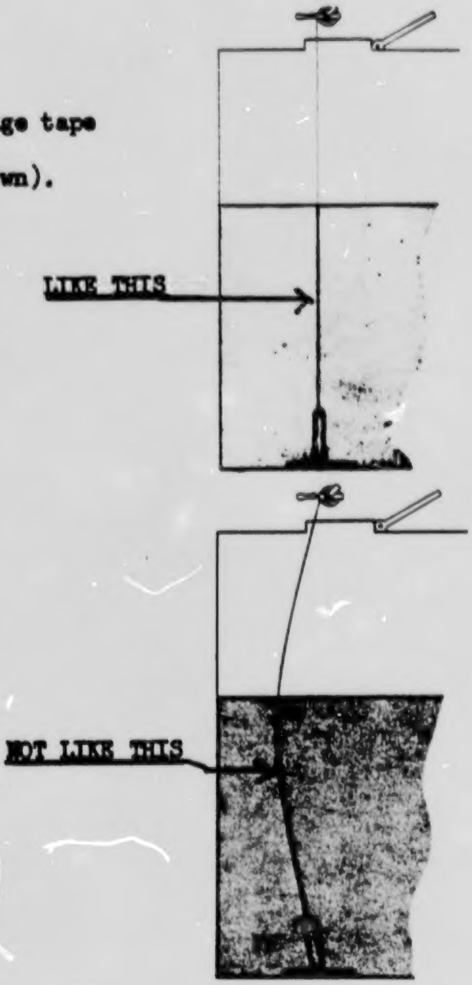
However, before you start to gage the tank, you must ground yourself. You can do this by touching the ladder or the wall of the tank with your hand.

As you lower the tape and bob into the tank, make sure that you hold the tape against the reference point of the tank. Then slowly lower the tape and bob into the tank until the tip of the bob just touches the ______________ ______________ on the bottom of the tank.


GAGING HATCH
INNAGE TAPE
INNAGE BOB
DATUM PLATE

486

You must make sure that the innage tape and bob are plumb (straight up and down).



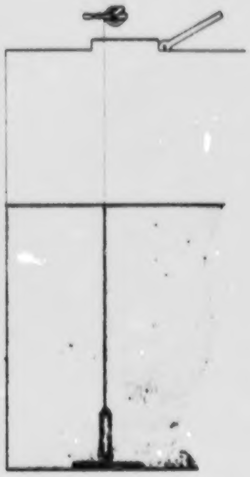
You can see that if the innage tape and bob are not plumb, or straight up and down, you will not get an accurate reading.

479

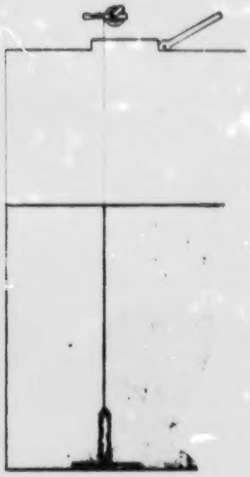
How can you be sure that the innage tape and bob are plumb?

You can compare the reading on the innage tape at the reference point with the reference height of the tank.

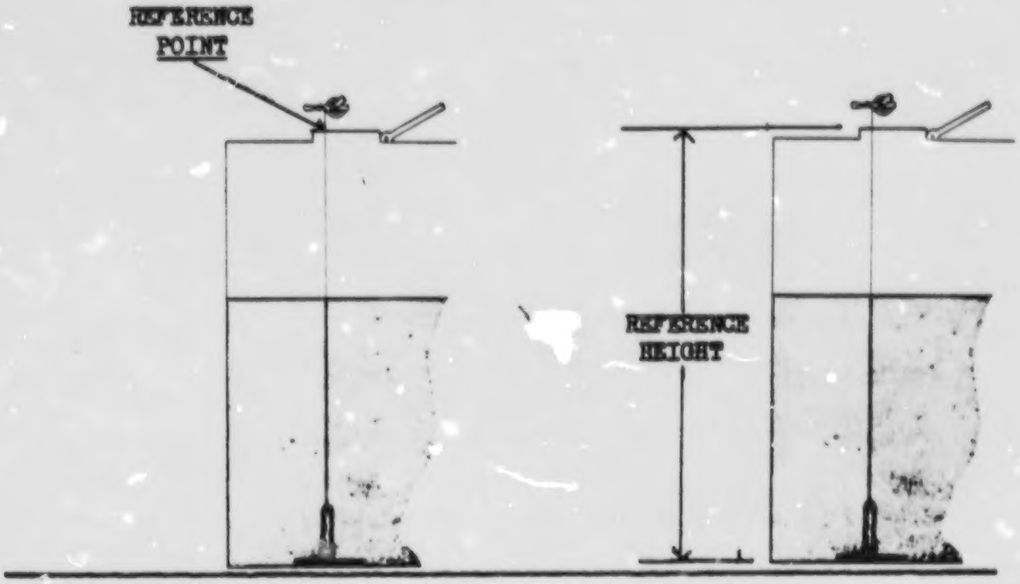
Draw an arrow to the reference point.



Draw lines to show the reference height.



488


REFERENCE POINT
REFERENCE HEIGHT

The reference height of the tank and the tape reading at the reference point should be the same. If the tape reading and the reference height are the same, you will know that the innage tape and bob are ______________.

481

plumb, or straight up and down

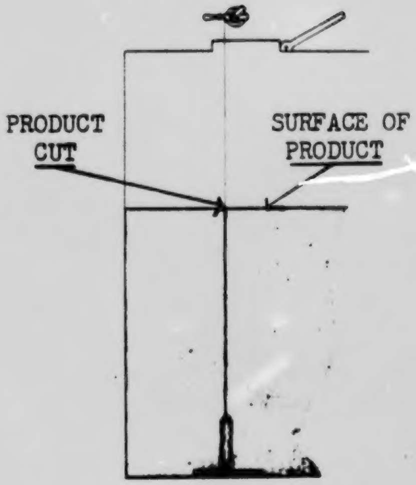
How long must you leave the tape and bob in place?

(How long does it take for
the paste to change color?)

490

1 minute

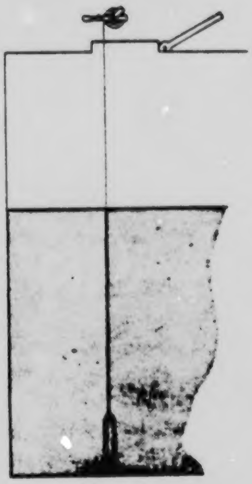
The next step is to reel in the tape until you come to the part where the paste has changed color. This is the part that was under the surface of the product. The place where the change in color begins is called the product cut.



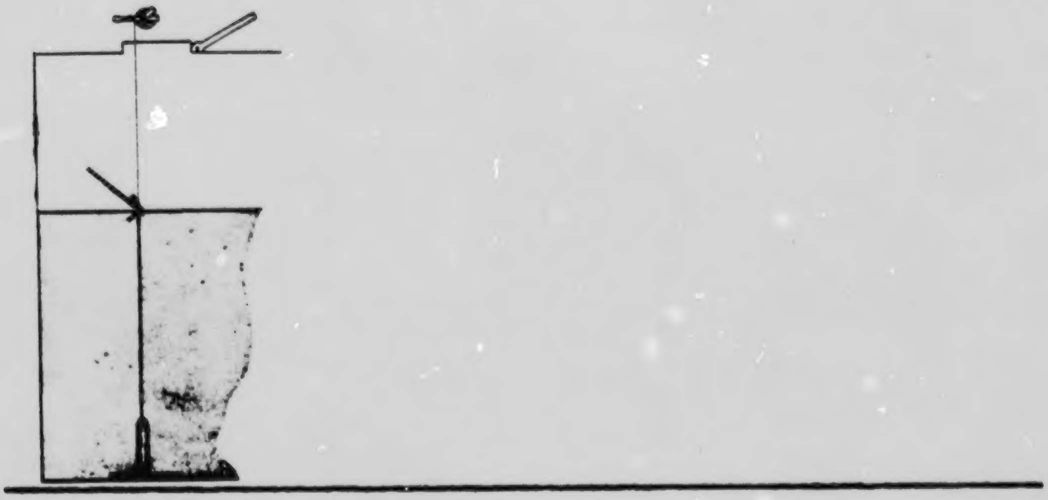
The next step is to read the measurement on the tape at the product cut. Read the measurement in feet and inches at the nearest 1/8 inch.

483

Draw an arrow to the product cut.



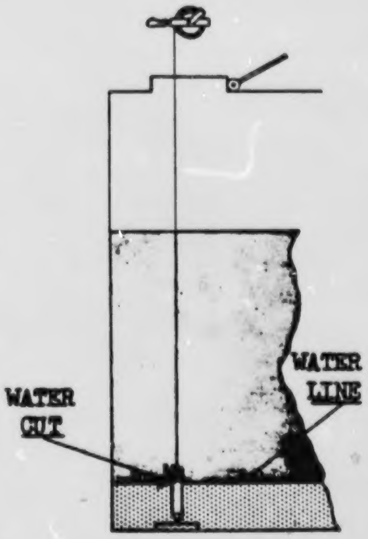
492



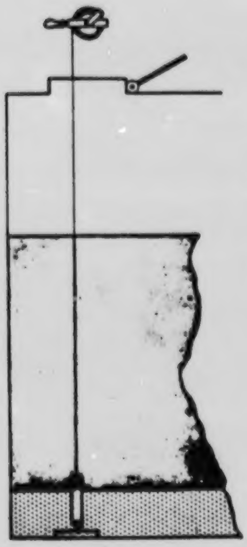
The measurement, or reading, on the tape at the product cut will tell you the depth of liquid in the tank. In other words, it will tell you the ________________.

Now you continue to reel in the tape and bob until the bob is out of the tank.

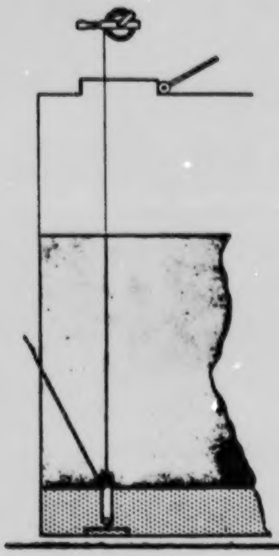
If there is any water in the bottom of the tank, the water-finding paste on the bob will have changed color from the water line to the tip of the bob. The place on the bob where the change in color begins is called the water cut.



Draw an arrow to the water cut.



487



The depth of BS&W in the tank will be the reading on the bob at the ______________ ________. You should take your reading in inches at the nearest 1/8-inch division.

496

To make sure that you have measured the innage and the BS&W accurately, you must wipe the tape and bob dry and then take another set of readings. Be sure to take off all of the old paste and put some fresh paste on the tape and bob.

If your second set of readings is not the same as the first set, you must continue to take readings until you get two tape readings that are the same and two bob readings that are the same.

Be sure to wipe the tape and bob dry between readings.

489

When you have ______ (how many?) tape readings and ______ (how many?) bob readings that are the same, you must record your measurements on the gager's worksheet.

Your innage measurement will be in ______ (feet, inches, or feet and inches?).

Your BS&W measurement will be in ______ (feet, inches, or feet and inches?).

498

two

two

feet and inches

inches

You will record both measurements at the nearest

______________________-inch division on the scale.
(1/16, 1/8, 1/4, or 1/2?)

491

1/8

You must remember to wipe the tape and bob dry after you have recorded your measurements.

TURN TO PAGE 45.

500

SELF-TEST

Directions: Answer items 1 and 6 below by filling in the blanks. Write your answer to item 16 in the space provided. In the other items, select the answer you think is correct and put a checkmark (✓) beside your choice.

1. After you have selected your innage tape and bob, you cover a part of the tape with a thin film of ________________-finding paste.
(gasoline or water?)

2. On which side of the tape do you put the paste?

A) On the back (smooth side).

B) On the front (side with the scale).

3. If the depth of liquid in the tank is approximately 6 feet, on which part of the tape should you spread the paste?

A) Between the 4- and 6-foot marks.

B) Between the 5- and 7-foot marks.

C) Between the 6- and 8-foot marks.

D) Between the 5 1/2- and 6 1/2-foot marks.

4. What kind of paste do you put on the bob?

A) Gasoline-finding.

B) Water-finding.

5. Where do you put this paste?

A) Over the entire bob.

B) Over the indentations and the tip.

C) From the top to the tip next to the indentations.

D) Down the back of the bob from the eye to the tip.

6. You must take two safety precautions in gaging. One is to ground yourself by touching the ______________ or the __________ of the tank. The other is to make sure that the tape touches the ______________________ ____________ as you lower the tape and bob into the tank.

7. The reference height of a tank is 8' 1". What reading should you have on the tape at the reference point if the tape and bob are plumb?

A) 7' 10"

B) 7' 11"

C) 8' 0"

D) 8' 1"

8. How long should you leave the tape and bob in place?

A) 1 minute

B) 2 minutes

C) 3 minutes

D) 4 minutes

9. Which reading gives you your innage measurement?

A) Reading on tape at reference point.

B) Reading on tape at product cut.

C) Reading on bob at water cut.

10. How do you find out the depth of BS&W in the tank?

A) Take reading on bob at water cut.

B) Subtract bob reading from tape reading.

C) Take reading on tape at product cut.

D) Subtract tape reading from reference height of tank.

11. Which of the following describes the number of tape readings you must take?

A) Take one reading but be careful to measure accurately.

B) Take readings until you get two that are alike.

C) Take two readings and average the readings.

D) Take three readings and average the readings.

12. You must read the tape at the nearest

A) inch.

B) 1/2 inch.

C) 1/4 inch.

D) 1/8 inch.

13. Which of the following describes the number of bob readings you must take?

A) Take one reading but be careful to measure accurately.

B) Take readings until you get two that are alike.

C) Take two readings and average the readings.

D) Take three readings and average the readings.

14. You must read the bob at the nearest

A) 1/16 inch.

B) 1/8 inch.

C) 1/4 inch.

D) 1/2 inch.

15. After you have taken the required number of tape and bob readings, where do you record your readings?

A) On a tag tied to the top of the tank.

B) On a scrap of paper.

C) On a gager's worksheet.

16. What must you remember to do between readings and after you have recorded your readings?

____

CHECK YOUR ANSWERS ON PAGE 49.

ANSWERS TO SELF-TEST ON PAGES 45-48

1. gasoline
2. A) On the back (smooth side).
3. B) Between the 5- and 7-foot marks.
4. B) Water-finding.
5. C) From the top to the tip next to the indentations.
6. ladder [or the] wall

   reference point
7. D) 8' 1"
8. A) 1 minute
9. B) Reading on tape at product cut.
10. A) Take reading on bob at water cut.
11. B) Take readings until you get two that are alike.
12. D) 1/8 inch.
13. B) Take readings until you get two that are alike.
14. B) 1/8 inch.
15. C) On a gager's worksheet.
16. Wipe tape and bob dry.

TURN TO PAGE 50 AND START SEQUENCE B.

497

SEQUENCE B

TAKING PRODUCT TEMPERATURE AT THE PROPER DEPTH

INTRODUCTION

In this sequence you are going to learn how to take the temperature of the product at the time of gaging. You will learn how to find out the proper depth or depths at which you will take the product temperature and how long to leave the thermometer in the product at each level. When you finish this sequence, you will have a practical exercise in taking the product temperature, following the procedures you will learn here.

OBJECTIVE

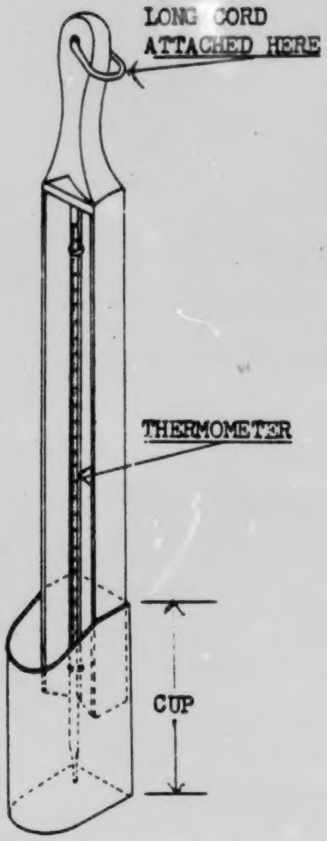
Given the innage measurement of a petroleum storage tank, the kind of product contained in the tank, necessary conversion tables, and a list of steps in taking the product temperature, you will be able to recognize the correct procedures in measuring temperature, as prescribed in TM 10-1101.

506

You will take the temperature of the product at the same time you gage the tank.

In fact, you will lower the thermometer into the tank before you lower the tape and bob.

This is a drawing of the thermometer you will use for taking the product temperature. It is called a cup-case thermometer.


LONG CORD
ATTACHED HERE
THERMOMETER
CUP

499

REMOVE PAGES 66 AND 67 FROM THE BACK OF THIS BOOK.

LOOK AT THE TABLE ON PAGE 66.

You can see that you will have to know approximately how deep the product is before you will know how far to lower the thermometer into the product and how many temperature measurements you will have to make. (Note. When you have your practical exercise after you complete this text, your instructor will tell you the approximate depth of the product in the tank. When you are in the field you can refer to your records to find out what the depth of product was the last time the tank was gaged.)

If the product is 11 feet deep, how many temperature measurements will you have to make?

____

At what level or levels will you take the product temperature? (Check one or more answers below.)

_____ 5 feet below surface of product.

_____ 3 feet below surface of product.

_____ Middle of product.

_____ 3 feet above bottom of tank.

_____ 5 feet above bottom of tank.

508

two

3 feet below surface of product
3 feet above bottom of tank

NOW LOOK AT THE TABLE ON PAGE 67.

You will see that the kind of product in the tank will determine how long you will leave the thermometer in the product at each measurement level.

If the product is kerosene, how long will you leave the thermometer in the product at each measurement level?

_________ minutes.

If the product is heavy lubricating oil, how long will you leave the thermometer in the product at each measurement level?

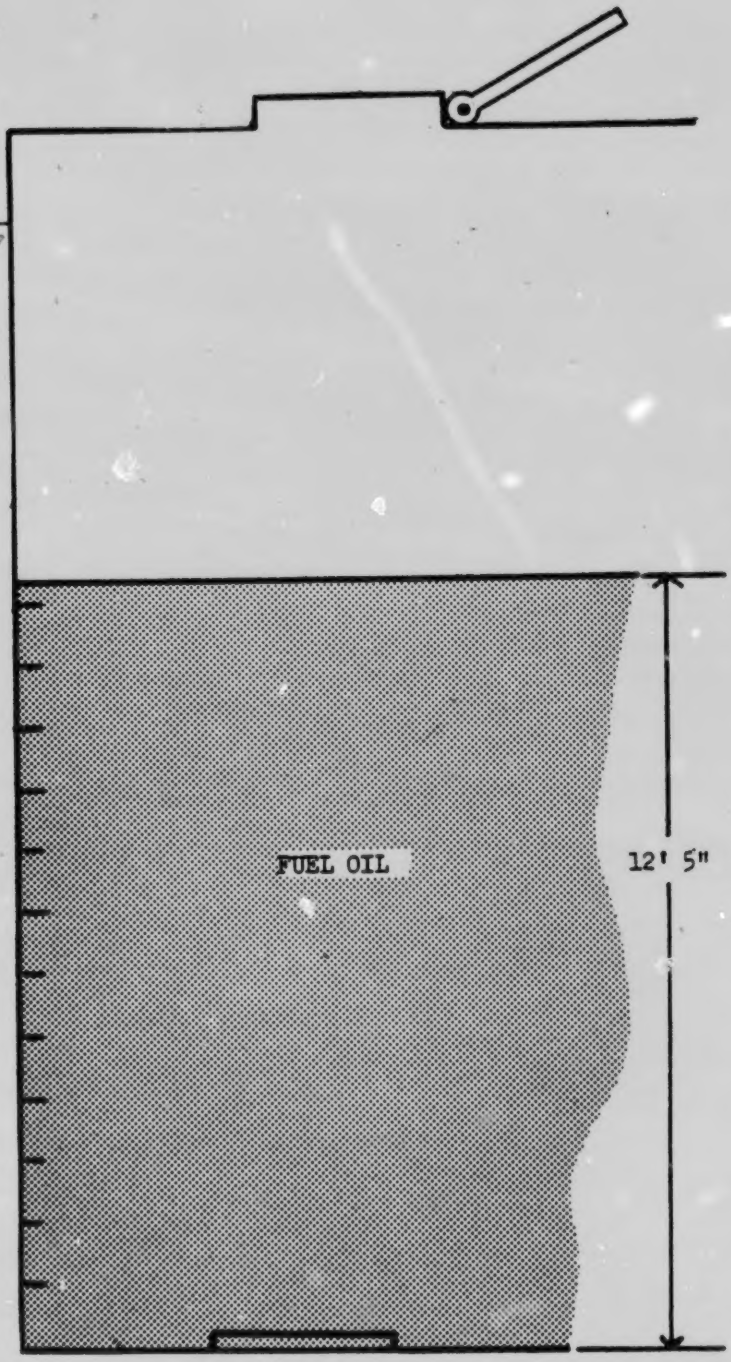
_________ minutes.

501

5

30

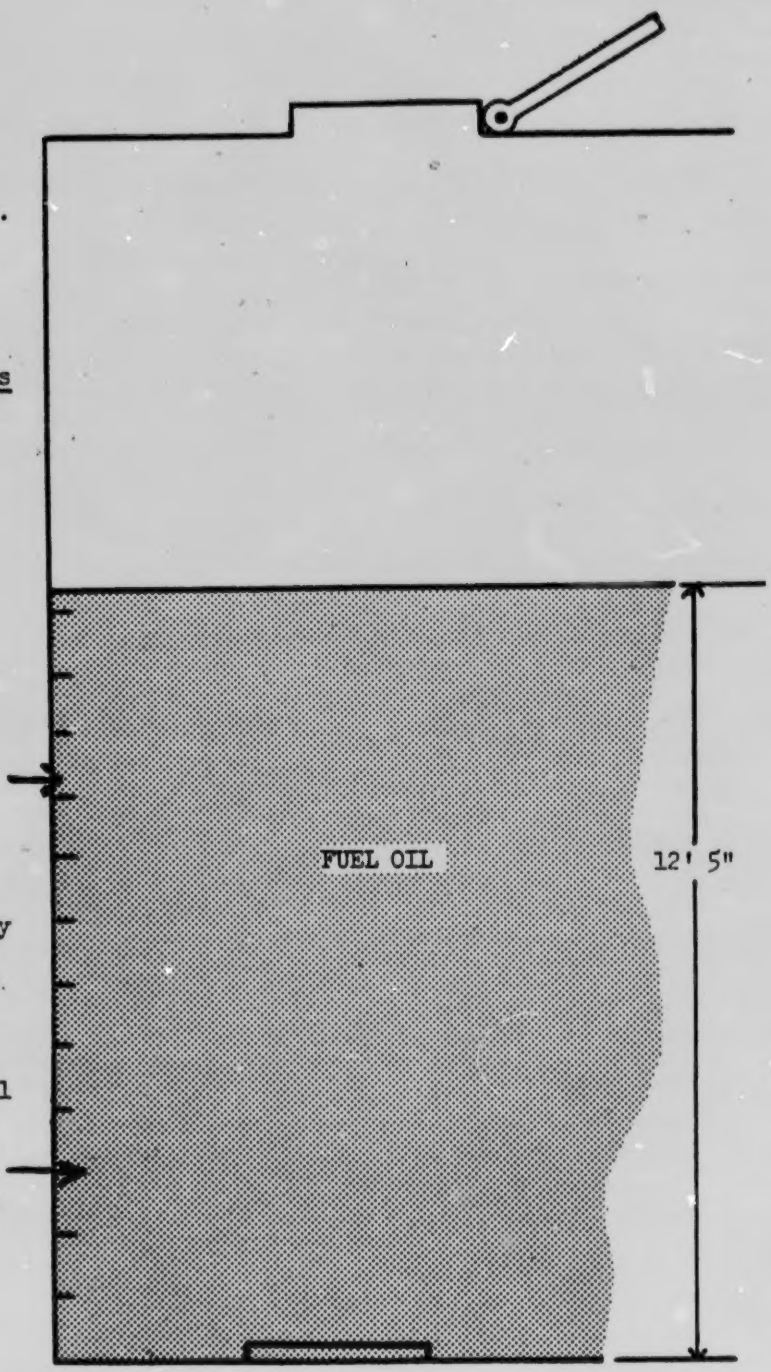
Draw an arrow or arrows to show where you would take the product temperature.



How long would you leave the thermometer in the product at each measurement level?

510

Your drawing should look like this. You would leave the thermometer in the product for 15 minutes at each measurement level.



Now you are ready to learn the steps in taking the product temperature. You will follow the same steps in taking the product temperature at each measurement level.

Do you remember what kind of thermometer we said you'd use for taking the product temperature? ______________________________

503

cup-case thermometer

The first step is to lower the thermometer into the tank to the right depth. You lower the thermometer through the sampling hatch.

If the innage measurement is 9 feet 9 inches, you will lower the thermometer to the ________________ of the product.

512

To hold the thermometer in place, you will tie the loose end of the cord (the other end is attached to the thermometer) to the lid of the sampling hatch. You must make sure that the thermometer is at least 12 inches from the tank wall.

505

Put a checkmark (✓) beside your answer to each of the following questions.

1. Through which opening in the tank do you lower the thermometer?

   Gaging hatch. __________

   Sampling hatch. __________

2. How do you keep the thermometer in place?

   Tie cord to lid of hatch. __________

   Hold the cord. __________

514

1. Sampling hatch.
2. Tie cord to lid of hatch.
3. 12 inches.

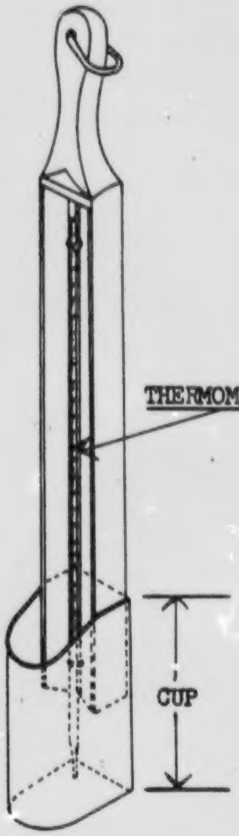
You must leave the thermometer in the product for the right length of time. If the product is kerosene, you will leave the thermometer in the product for ______________.
(how long?)

507

5 minutes

After the thermometer has been in the product long enough, pull the thermometer up rapidly with the cup full of ____________________.
Then read the thermometer quickly and record the

________________________________.



product

temperature

If you take the product temperature at only one level, you will immediately record your reading on the gager's __________________________. However, when the product is deep enough for you to take the temperature at two or three levels, you must find the average temperature and record this temperature on the __________________ __________________________.

509

workshset

gager's workshset

If you take the product temperature at two levels, you can find the average temperature by adding the two temperature readings together and dividing by 2. If you take the product temperature at three levels, you can find the average temperature by adding the ________ (how many?) readings together and dividing by ________.

518

SELF-TEST

Directions: Fill in the blank in item 3. In the other items, select the answer you think is correct and put a checkmark (✓) beside your answer.

1. When will you lower the thermometer into the tank to take the product temperature?

A) Before you lower the tape and bob into the tank.

B) After you have finished gaging the tank.

2. What kind of thermometer will you use for taking the product temperature?

____________________ thermometer.

3. You will take the temperature of a product at either one, two, or three levels. What determines the number of levels?

A) The kind of product in the tank.

B) The depth of the product.

4. What determines how long you will leave the thermometer in the product at each measurement level?

A) The kind of product in the tank.

B) The depth of the product.

5. The depth of product in a tank is approximately 9' 9". You have found that the temperature at the middle of the product is 48° F. What will you do next?

A) Take another temperature reading.

B) Record your reading on the gager's worksheet.

6. The depth of product in a tank is 11' 3". You have found that the temperature of the product at a point 3 feet above the bottom of the tank is 47° F. and that the temperature of the product at a point 3 feet below the surface is 49° F. What will you do next?

A) Take a temperature reading at the middle of the product.

B) Record a reading of 47° F. on the gager's worksheet.

C) Record a reading of 48° F. on the gager's worksheet.

D) Record a reading of 49° F. on the gager's worksheet.

CHECK YOUR ANSWERS ON PAGE 65.

ANSWERS TO SELF-TEST ON PAGES 63 AND 64

1. A) Before you lower the tape and bob into the tank.

2. Cup-case thermometer.

3. B) The depth of the product.

4. A) The kind of product in the tank.

5. B) Record your reading on the gager's worksheet.

6. C) Record a reading of 48° F. on the gager's worksheet.

DIRECTIONS FOR MEASURING PRODUCT TEMPERATURE

Depth of product	Minimum number of temperature measurements	Measurement levels
20 feet and over	3	5 feet below surface of product, middle of product, and 5 feet above bottom.
15 feet to 20 feet	3	3 feet below surface of product, middle of product, and 3 feet above bottom.
10 feet to 15 feet	2	3 feet below surface of product and 3 feet above bottom.
Less than 10 feet	1	Middle of product.

LENGTH OF TIME TO LEAVE THERMOMETER IN PRODUCT

Product	Minimum time
Gasoline, naphtha, and kerosene	5 minutes
Light lubricating and fuel oils	15 minutes
Heavy lubricating, cylinder, gear, and residual oils	30 minutes

515

QMS 300.503 H-2

U.S. ARMY QUARTERMASTER SCHOOL

GAGING AND SAMPLING

Table of Contents

	Page
Introduction	1
Gaging	1
General	1
Definitions	1
Shore Tanks	2
Tank Cars	7
Ship's Cargo Tanks and Barges	9
Sampling	12
General	12
Definitions	12
Containers Used for Sampling	13
Quantity of Sample	14
Sampling Equipment	14
Annexes	
A References	
B 500 BBL Strapping Chart	

PROPONENT DEPARTMENT: PETRL & FLD SVCS

November 1976

GAGING AND SAMPLING PETROLEUM PRODUCTS

INTRODUCTION

Of paramount importance in the distribution of petroleum products is the need for precise measurements of these products coupled with exacting methods for the prevention of contamination and its immediate detection when it occurs. The personnel of a properly operated depot should strive for accuracy in gaging, care in taking samples, and see that they are properly and promptly tested. It is the purpose of this handout to act as a general guide to this end.

GAGING

1. General.

The single term gaging includes the measurement of the height of the product surface above the tank bottom, the depth of the water if any on the tank bottom, and the product temperature. Gaging as it will be discussed here shall be limited to a general description of the methods applied to (A) Shore Tanks, (B) Tank Cars (non-pressure), and (C) Ships Cargo Tanks and Barges. For special containers or for a more detailed description of the methods and equipment described here a list of references is attached hereto. (See Annex A).

2. Definitions.

a. Reference Mark: A horizontal line cut in the rim of the gaging hatch representing a fixed point from which measurements are made.

b. Reference Height or Gaging Height: The distance from the reference mark to the tank bottom or datum plate.

c. Datum Plate: A level metal plate at the tank bottom and directly under the reference mark. This plate provides a smooth, level surface for the innage bob to rest upon.

d. Tape Cut: The line of demarcation on the tape made by the product measured.

e. Bob Cut: The line of demarcation on the bob made by the amount of BS+W measured.

f. Innage Gage: The depth of liquid in a tank measured from the surface of the liquid to the tank bottom.

g. Outage Gage: A linear measurement of the free space above the surface of the liquid extending to the reference mark.

h. Shell Full: Used in tank car operations. Refers to the product in a tank car when the product just touches the underside of the top of the shell and does not extend into the dome.

i. Shell Innage: Depth of a product in a tank car shell.

j. Shell Outage: Distance from the reference point on the upper lip of the tank shell to the surface of the product.

k. Dome Innage: The measurement of product in the dome from the top of the upper lip of the inner shell to the liquid surface in the dome.

l. Bottom Sediment and Water (BS+W): A linear measurement of any sediment and free water which may be present in the tank bottom. It is that portion of the tank contents which is unsuitable for use. Water bottoms should be kept to a minimum and used only as cushions in a leaky tank bottom.

m. Total Measured Quantity: The volume of product and BS+W in a tank for a given gage at the observed temperature of product at the time of gaging.

n. Net Volume of Product, Uncorrected: The total measured quantity less BS+W at observed temperature.

o. Net Quantity of Product at 60°F.: The measured quantity converted to the equivalent volume at 60°F. after BS+W has been deducted.

p. Delivered Quantity at 60°F.: The difference between the quantities at 60° figures from the opening and closing gages. It is the quantity at 60°F. delivered from or to a tank.

q. Outage: A linear measurement of the vapor space above the product in a storage tank. (Same as ullage - a common term used in waterfront operations.)

3. Shore Tanks

The methods and definitions described here apply specifically to "Fixed Roof, Atmospheric Tanks" but apply in a general manner to all types of shore tanks.

a. General Instructions

(1) Whenever possible, the pipeline used should be full for both opening and closing gages. If this is not possible, then every effort should be made to have the line in the same condition for the opening and closing gage.

(2) Gages shall be taken as soon as possible after loading or discharging. However, sufficient time should be allowed for settling, air expulsion, etc., after deliveries to the tank have been made. The tank should not be gaged when there is still evidence of air expulsion (as noted by air bubbles breaking at surface of the product). In the case where there is foam on the surface, the gage shall be allowed to stand at least one-half hour to allow the product to settle before the closing gage is taken.

(3) The gage tape shall be read and recorded to the nearest 1/8 inch.

(4) Standing on the roof shall be avoided to prevent depressing the reference mark. This is especially important in outage gages.

(5) Flexible bottoms shall be blanketed with water whenever this practice is specifically authorized.

(6) Full compliance with safety rules is required.

b. Reference Mark and Reference Depth

A definite reference mark shall be marked on the gaging hatch. The distance from the bottom of the tank to the reference mark shall be called the reference depth. All gaging shall be done at the reference mark location.

c. Outage and Innage

(1) Outage: To determine a tank "outage", the distance from the surface of the product to the reference mark shall be measured. "Outage" is a measure of the unfilled portion of the tank. An outage tape and bob are used. The bob and tape are lowered through the gaging hatch until the bob cuts the surface of the liquid. A tape reading at the reference mark is taken and the bob is withdrawn, and the "cut" on the bob read. Both readings shall be recorded. The tape reading plus the bob reading equals the outage.

(2) Innage: To determine the tank "innage", the distance from the bottom of the tank to the surface of the product shall be measured. "Innage" is a measure of the filled portion of the tank. An innage bob and tape shall be used. The bob shall be lowered through the gaging hatch until the tip of the bob just touches the bottom of the tank. The "cut" on the tape represents the innage. A tape reading shall also be taken at the reference mark and this reading shall be checked against the reference depth to insure against the possibility of the bob resting on some projection on the bottom.

NOTE: Where the "cut" on the tape is not readily legible, a thin film of light grease or an approved oil-finding paste shall be used to check the gage.

d. Bottom Sediment + Water

(1) Innage Method: An "innage bob" shall be coated on one side with a thin even film of an approved water-finding paste. The bob is then lowered as described in paragraph A (3b) above. The two procedures are usually carried out simultaneously using the same bob and tape. Ten seconds time is usually allowed for gasoline and kerosene, 30 to 60 seconds for heavier products. The distance from the tip of the bob to the "cut" shall be measured and recorded as water innage.

(2) Outage Method: In cases when it is not possible to accurately determine the free water and sediment by the innage method it may be determined by the outage method. In such cases an outage bob is coated with paste and lowered to such a depth (measured from the reference mark) that the bob projects beneath the surface of the water but does not rest on the bottom. The tape reading at the reference mark shall be recorded and when the bob has been suspended long enough to obtain a "cut" it shall be withdrawn and the bob "cut" read. The bob "cut" reading plus the tape reading represents the water outage; this figure subtracted from the reference depth represents the depth of water and sediment in the tank.

e. Temperature

Temperature measurements are taken almost without exception whenever gages are taken for accounting purposes, to determine inventory on hand, product received, or product delivered. To minimize the effects of volumetric change due to thermal differences at the point of loading and at the point of delivery all volumes are corrected from the observed temperature to their "corrected volumes" at 60°F. The Volume Correction Table for Petroleum Oils is used for this purpose. API Gravity should be taken so as to determine the API Gravity Group in which the product falls. The corresponding Volume Correction Table shall be used.

The reading of the temperature may be the largest single factor contributing to gaging error. For instance, an error of only 2°F in a 20 ft depth is equivalent to an error of 1/4 of an inch or more on the gage table.

(1) Number of readings: The number of temperature measurements to be taken is a compromise between ideal accuracy and practicality. It is determined arbitrarily by the product depth as follows:

Depth of Produce	No. of Readings	Points at which Readings shall be Taken
20 feet and over	3	5 feet below top surface of product, middle of product and 5 feet above bottom.
15 feet to 20 feet	3	3 feet below top surface of product, middle of product and 3 feet above bottom.
10 feet to 15 feet	2	3 feet below top surface of product, and 3 feet above bottom.
Less than 10 feet	1	Middle of Product

All temperature readings are averaged arithmetically to obtain the average product temperature. (The temperature readings must be made at the time of the gaging in order to be of use in correcting the volume.)

(2) Procedure: An approved cup type thermometer shall be lowered to the specified depth and allowed to remains as follows:

Minimum Immersion Time for Cup Case Thermometer

PRODUCT	MINUTES
Gravity groups 3 & 4, API 51.09°-78.9°-Mogas-Avgas	15
Gravity group 2, API 35.0°-50.9° Kero, Diesel, Jet Fuel, Solvent	15
Gravity group 1, API 15.0°-34.9° Lubricating Oils, NSFO	30

The cup of the thermometer shall be full when withdrawn and the temperature reading taken with the thermometer sheltered to minimize the changes in reading do to atmospheric conditions.

f. Gaging a Storage Tank.

(1) Innage Method.

(a) Select innage tape and bob (the first visible number on the innage tape is 10, the innage bob is pointed).
(b) Select thermometer.
(c) Select gagers work sheet.
(d) Find out which tanks are to be gaged.
(e) Check reference height at the tanks gaging hatch.
(f) Lower tape with bob into the tank until the tip of the bob just touches the floor, or datum plate on the floor of the tank. (Check tape reading against reference height which is painted on the tank at the gage hatch). DO NOT STAND ON ROOF OF TANK WHILE GAGING.

(g) Take readings until at least two gaging readings are the same. (Read innage depth where product cuts the tape).

(h) Record tape reading on gage sheet, and wipe tape dry.

(i) Smear a thin film of water finding paste on the innage bob.

(j) Lower the tape and bob into the tank to measure free water and sediment (BS&W) at the bottom of the tank. Let it set about 1 minute.

(k) Withdraw, wipe, and reel tape. Read depth of free water and sediment where the bob is discolored.

(l) Record this reading on the gage sheet.

(m) Lower the thermometer into the storage tank until it reaches the approximate mid-depth of product in the tank, preferably at the center hatch of the tank.

(n) Let thermometer remain in the tank for 3 to 5 minutes.

(o) Pull up rapidly with cup full of product.

(p) Read as quickly as you can and record in the space provided on gage sheet.

(2) Outage Method

(a) Select outage tape and bob (the first visible number on the outage tape is 4. The outage bob is rectangular.)

(b) Select thermometer.

(c) Select gagers work sheet.

(d) Find out which tanks are to be gaged.

(e) Check reference height at the tank gaging hatch. (DO NOT STAND ON ROOF OF TANK WHILE GAGING).

(f) Lower tape into tank until the bob breaks the surface of the liquid, then lower tape an inch or two more until there is an even tape reading at the gage hatch or reference point. (This prevents having fractional readings on both the tape and bob.)

(g) Gage tank and read tape and bob until two readings are the same.

(h) Record readings and wipe bob and tape dry.

g. Converting Liquid Depth to U. S. Barrels or Gallons

(1) Change measured depth to barrels or gallons (Use the strapping chart for the tank gaged) to find total innage.

(2) Change bottom, sediment and water measurement (BS&W) to gallons or barrels.

(3) Subtract gallons or barrels of BS&W from total innage. The remainder is true innage.

(4) Read down left column of abridged tables (Table VIII, pages 177 thru 184 TM 10-1101). Find observed temperature (Temperature read from the cup case thermometer when you gaged the tank).

(5) Read across top of abridged tables (Table VII). Find liquids' API gravity range and group number. (Example: 15.0-34.9° API places liquid in group number 1.)

(6) Select multiplier or correction factor by reading down the column under the selected group number to the line opposite the observed temperature. (Example: 32° API places liquid in Group Number 1. If observed temperature is 48°F, the multiplier or correction factor is 1.0048. See Table VIII, page 178, TM 10-1101).

(7) Multiply true innage (gallons or barrels) found in Step 3, by the multiplier or correction factor found by using method explained in Step 6. The result is barrels or gallons at 60°F.

4. Tank Cars (Non-Pressure Type)

The following information shall apply specifically to the non-pressure type tank cars with exception of the general instructions which so far as they are listed apply to both types. For instructions on sampling and gaging of pressure types see reference attached hereto. (See Annex A).

a. General Instructions

(1) Tank cars shall be on level trackage when being gaged.

(2) All gages shall be read to the nearest 1/8 inch.

(3) The gager must report all gages as measured. Any adjustments or corrections shall be made by the accounting section.

(4) Superiors shall be notified if any physically or mechanically defective cars are received.

(5) Full compliance with all safety rules is required.

b. Procedure

523

(1) Equipment: Equipment shall consist of a "short" pole for measuring shell outages or dome innages and a "long" pole for measuring free water and sediment or residue innages.

The "short" pole is 36" long, graduated in 1/8 inch divisions with the "0" mark 12 inches from one end. A brass angle is attached to the pole at a point 3/8 of an inch over the "0" mark to allow for nominal shell thickness so that all measurements start from the underside of the top of the shell.

The "long" pole is ten feet long, graduated in 1/8 inch divisions for the first 12 inches and 1/4 inch divisions for the remainder of the pole. The bottom of the pole is equipped with a graduated, 4-inch hard non-spark tip to protect it from damage and to aid in penetrating heavy residue.

(2) Gaging Full Cars: The "short" pole is inserted with the short end down through the gaging hatch and the angle placed on the edge of the tank shell which protrudes into the dome. This gaging point shall be the highest point if the tank shell is on a line with longitudinal center of the tank. Care must be taken that the angle does not rest on a rivet head and that the pole is in a perpendicular position with respect to the car level. The pole shall be withdrawn and the product level "cut" read to the nearest 1/8 inch. If the cut is below the "0" mark the reading shall be recorded as "shell outage"; if above the "0" mark the reading shall be recorded as "dome innage".

NOTE: Innage measurements of full cars may be made with the long pole in the same manner that residue innages are taken (B, d). However, this is not recommended except in the cases where "shell outage" is more than 12 inches.

c. Residue: Residue, after discharging and before loading shall be measured with a "long"pole. The pole shall be lowered through the dome hatch perpendicular to the car level, care being taken so that the pole does not rest on a rivet head. The pole shall be withdrawn and read to the nearest 1/8 inch. The reading shall be recorded as "residue innage".

d. Bottom Sediment + Water: The end of the pole shall be coated with a light even coat of water finding paste. The end of the "long" pole shall be lowered in the same manner as above and held long enough to obtain a "cut". The pole shall be withdrawn. The "cut" shall be read to the nearest 1/8 inch and recorded as "free water and sediment innage".

e. Temperature

The same type thermometer as is used in gaging shore tanks shall be used for tank cars.

(1) Procedure: The thermometer shall be lowered to the middle

532

of the contents of the car and allowed to remain for sufficient time to reach constant temperature. The thermometer shall be withdrawn and read in the manner previously described for shore tanks.

(2) Number of Readings: When loading non-heated materials, the temperature on at least 10% (3 minimum) of the number of cars selected at random shall be taken. When loading heated materials, the temperature of each car shall be taken. When unloading, the temperature of each car shall be taken.

5. Ship's Cargo Tanks and Barges

The methods and definitions described herein apply specifically to ship's cargo tanks but are similar to those applied to barge tanks. The general instructions which follow are equally applicable to either case.

a. General Instructions

(1) When a vessel is scheduled to load, the vessel's hull, lines, valves and bulkheads shall be inspected for leaks, dents, cement boxes, or any other physical irregularities which would affect the accuracy of the cargo measurements.

(2) The vessel's tanks shall be inspected, before loading, for the presence of water, sediment, or other material. If any of these conditions are observed, a report must be made to superiors before loading.

(3) Gages shall be read and recorded to the nearest 1/8 inch.

(4) The contents of all cargo compartments shall be measured before and after loading or discharging of any cargo. These measurements shall be taken in the presence of and attested to by one of the ship's deck officers.

(5) When part cargoes are loaded or discharged at more than one port or terminal, the contents of all cargo compartments shall be measured before and after each part loading or discharging.

(6) Full compliance with safety rules is required.

b. Reference Mark and Reference Depth

The established reference mark shall be the top rim of the outboard side of the gaging hatch. The distance from this point to the bottom of the tank shall be known as the reference depth. All gaging shall be done at the reference mark location.

c. Procedure

(1) Outage (Ullages).

QMS 300.154 H2
QMS 300.574 H1

To determine a tank "outage", the distance from the surface of the product to the reference mark is measured. An outage tape and bob shall be used. The bob shall be lowered through the gaging hatch until a product "cut" is obtained on the bob. A tape reading shall be taken at the reference point. The tape shall be withdrawn and the "cut" on the bob read. Both readings shall be recorded. The tape reading plus the bob reading represents the outage.

(2) Innage readings are usually not taken on ship's cargo tanks, but may be taken with a gaging pole in a barge tank when said tank is equipped with "datum plates".

d. Residue: Residue before loading and after discharging shall be measured by lowering the "sounding bob" attached to an outage tape through the gaging hatch until the bob just touches the bottom of the tank. The bob shall be withdrawn and the "cut" read. The bob "cut" represents the residue "innage" (An innage bob and tape may be used for this measurement. In this case the tape reading at the reference mark equals the reference height.)

e. Bottom Sediment + Water

To determine bottom sediment + water, follow procedure outlined above (B4) coating the bob with a light, even coat of water-finding paste. The reading is recorded as water "innage".

f. Temperature

(1) Procedure

The thermometer shall be lowered to a point midway between the surface of the product and the bottom of the tank and allowed to remain there for a sufficient time to reach a constant temperature. The cup of the thermometer shall be full when withdrawn and the temperature reading shall be made with the thermometer sheltered in order to minimize the effect of atmospheric conditions.

(2) Number of Readings: If a cargo consists of one grade, temperature readings shall be obtained in at least one-third of the compartments as is illustrated below for a T-2 type tanker:

Tank No.	9	8	7	6	5	4	3	2	1
Port			Temp			Temp			Temp
Pump Room		Temp			Temp			Temp	
Starboard	Temp						Temp		

Temperature Schedule (Single Grade Cargoes)

Temperature of mixed cargoes shall be obtained as follows:

Number of Compartments Containing Same Product	Minimum Number of Temperature Determinations
1 or 2	Each
3 to 6	2
7 or more	1/3 of the compartments (3 minimum)

g. Draft Readings

Fore and aft draft readings shall be taken before and after loading or discharging, preferably in the presence of the ships dock officer. The draft measurements can be read directly from the draft numbers painted on the bow and stern of the vessel. These draft measurements are reported only for auditing purposes by the loading agency, and are used to determine the tilt of the vessel so the innage or outage measurements of the barge compartments may be adjusted accordingly.

SAMPLING

1. General

Samples are taken for the purpose of having representative quantities, of economical and convenient size, from a section, or from the whole of a lot of material, for examination and test, so that agreement may be reached in regard to the following:

a. The extent of variation of qualities in different portions of the lot, and,

b. The average quality of the whole lot of material.

The laboratory must analyze the product on the basis of the contents submitted in the sample containers. If a sample is not truly representative of the product because of improper sampling procedure, or is contaminated through carelessness, the test results obtained will be no better than the quality of the sample submitted. It is useless to test and draw any conclusions from results that have been secured on samples that are not absolutely representative of the product in the tank or compartment. The importance of representative samples cannot be stressed too much.

2. Definitions

a. All Levels Sample is one obtained by submerging a closed container as near as possible to the draw-off level, opening it and raising it at such a rate that it will be nearly but not quite full when withdrawn.

b. Upper Sample is one obtained from the middle of the upper third of the tank contents.

c. Middle Sample is one obtained from the middle of the tank contents.

d. Lower Sample is one obtained from the middle of the lower third of the tank contents.

e. Single Tank Composite Sample is a blend of the upper, middle, and lower samples. For a tank of uniform cross-section, such as an upright cylindrical tank, the blend consists of equal parts of the three samples. For a horizontal cylindrical tank, the blend consists of the three samples in the proportions shown in the following table:

LIQUID DEPTH, PER CENT OF DIAMETER	PERCENT OF DIAMETER ABOVE BOTTOM			COMPOSITE SAMPLE, PROPORTIONATE PARTS OF		
	UPPER	MIDDLE	LOWER	UPPER	MIDDLE	LOWER
100	80	50	20	3	4	3
90	75	50	20	3	4	3
80	70	50	20	2	5	3
70	...	50	20	...	6	4
60	...	50	20	...	5	5
50	...	40	20	...	4	6
40	...	...	20	...	...	10
30	...	...	15	...	...	10
20	...	...	10	...	...	10
10	...	...	5	...	...	10

f. Multiple Tank Composite Sample (Ship, Barge, etc.) is a blend of individual all-levels samples, from each compartment which contains the product being sampled, in proportion to the volume of material in each compartment.

g. Top Sample is one obtained 6 in. below the top surface of the tank contents.

h. Bottom Sample is one obtained from the material on the bottom surface of the tank, container, or line at its lowest point. (Drain and bottom samples are usually taken to check for water, sludge, scale, etc.)

i. Outlet Sample is one obtained at the level of the tank outlet (either fixed or a swing line outlet).

j. Continuous Sample is one obtained from a pipeline conveying the product in such manner as to give a representative average of the stream throughout the period of transit.

k. Tube or Thief Sample is one obtained with a sampling tube or special thief, either as a core sample, or spot sample from a specified point in the container.

3. Containers Used for Sampling

Samples of the various grades of oil shall be taken in one-quart containers, two types of which are (1) the weighted beaker and (2) the weighted bottle. The following list shows the types of containers recommended for use with various grades of oil:

a. Heavy crudes and fuel oils - weighted beaker or bottle with 1 1/2" opening.

b. Light crudes, diesel fuel, distillates and non-transparent gas oils - weighted beaker or bottle with 3/4" opening.

c. Heavy lubricating oils - weighted bottle with 1 1/2" opening.

d. Light lubricant oils, refined oil, gasoline, transparent gas oils, diesel fuel, distillates and non-transparent gas oils - weighted bottle with 3/4" opening.

4. Quantity of Sample

a. Samples from Loading Operations

Shore tanks & composite	5 or 10 quarts (Par 3)
Shore pipeline composite	1 gal
Ship's composite	1 gal
Individual ship's tanks	At least 1 qt.

b. Samples from Discharging Operations

Ship's composite	1 gal
Individual ship's tanks	At least 1 qt.

NOTE: All motor and aviation gasolines and jet fuels require a minimum sample of two gallons. Supercharge engine method requires a 5 gallon sample. Jet fuels, two gallons, 10 gallons for thermal stability test. Diesel and fuel oils, 1 gal samples.

c. Greases

(1) Less than one pound - select sufficient units at random to provide a two pound sample from each shipment or lot.

(2) In one pound cans, three cans shall be selected at random to provide the sample from each shipment or lot.

(3) In 5 or 10 pound cans, one can be selected at random to provide the sample from each shipment or lot.

d. Samples drawn from drums: The number of samples drawn shall be equal to the cube root (or the next larger whole number) of the total number of packages in the lot. Samples drawn from drums shall be at least of 1 qt size.

5. Sampling Equipment

a. Weighted Bottle.

This consists of a glass bottle with a cork stopper, and is encased with a lead sheath to weight the bottle. A short cord is attached to stopper which in turn is attached to a longer cord attached to bottle. The stopper can be removed by a quick jerk on the cord. The bottle has a fairly wide mouth for use with heavier products. It is used primarily to take all-levels and composite samples.

b. Weighted Beaker.

This consists of a copper beaker, also with a lead sheath which is not removable. Here again we have the cork stopper and strings which serve the same purpose as with the weighted bottle. The mouth of the beaker is rather small for use with the lighter products, 3/4 and 1½ inch for heavier oils. It is used primarily to take all-levels and composite samples.

c. Tulsa Thief.

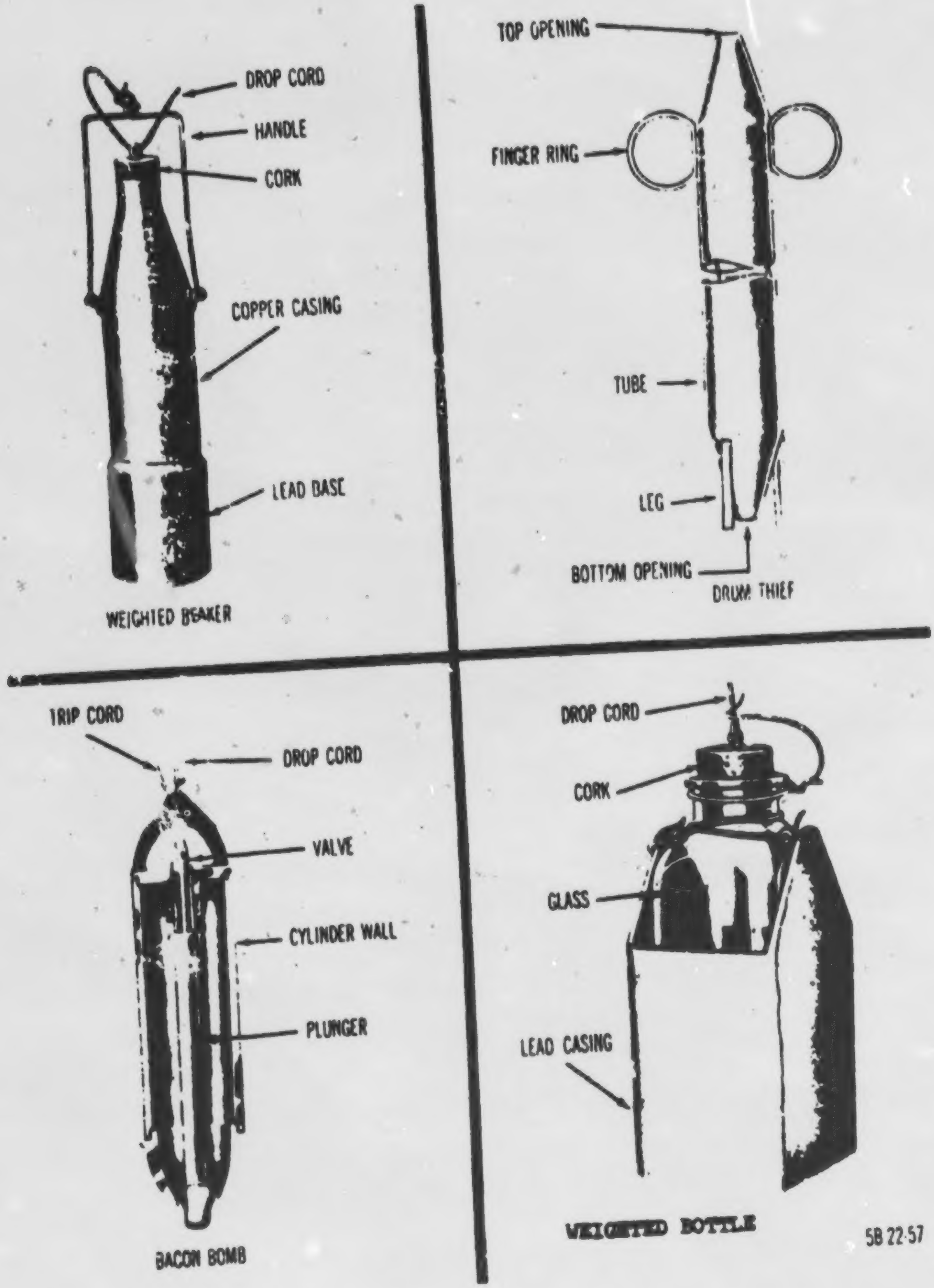
This piece of equipment consists of a tube about 12 inches long and about 2 inches in diameter, cylindrical in shape, with a graduation on its exterior. The tube has a spring trap door at the bottom which when opened, allows product to pass through the tube when lowered into product. The door may be sprung closed with a mechanism at the top by a quick jerk on the attached chain. This traps the product in the tube at that time. It is used for taking top, upper, middle, and lower samples.

d. Tank Car Thief or Bacon Bomb.

Here we have a rather heavy torpedo shaped tube with a plunger from top to bottom. The plunger forms a type of plug valve at the bottom which opens when it is resting on a solid and closes when lifted. This plunger can also be controlled at any depth in the liquid by means of a chain attached to the eye in top of plunger. This chain would be independent of the chain used for raising the sampler. This piece of equipment is usually used in obtaining bottom samples from tank cars, and fixed storage tanks.

e. Drum Thief.

This consists of a transparent plastic tube about 1 inch in diameter and slightly longer than the depth of a drum. Both ends are tapered and open. At the top are two loops for finger holes. It is used to obtain a sample from a drum. Lower thief into drum through bung hole, placing thumb over top opening when tube is filled at desired depth. This will trap the liquid until it can be withdrawn from drum and properly transferred to sample container.



WEIGHTED BEAKER

DRUM THIEF

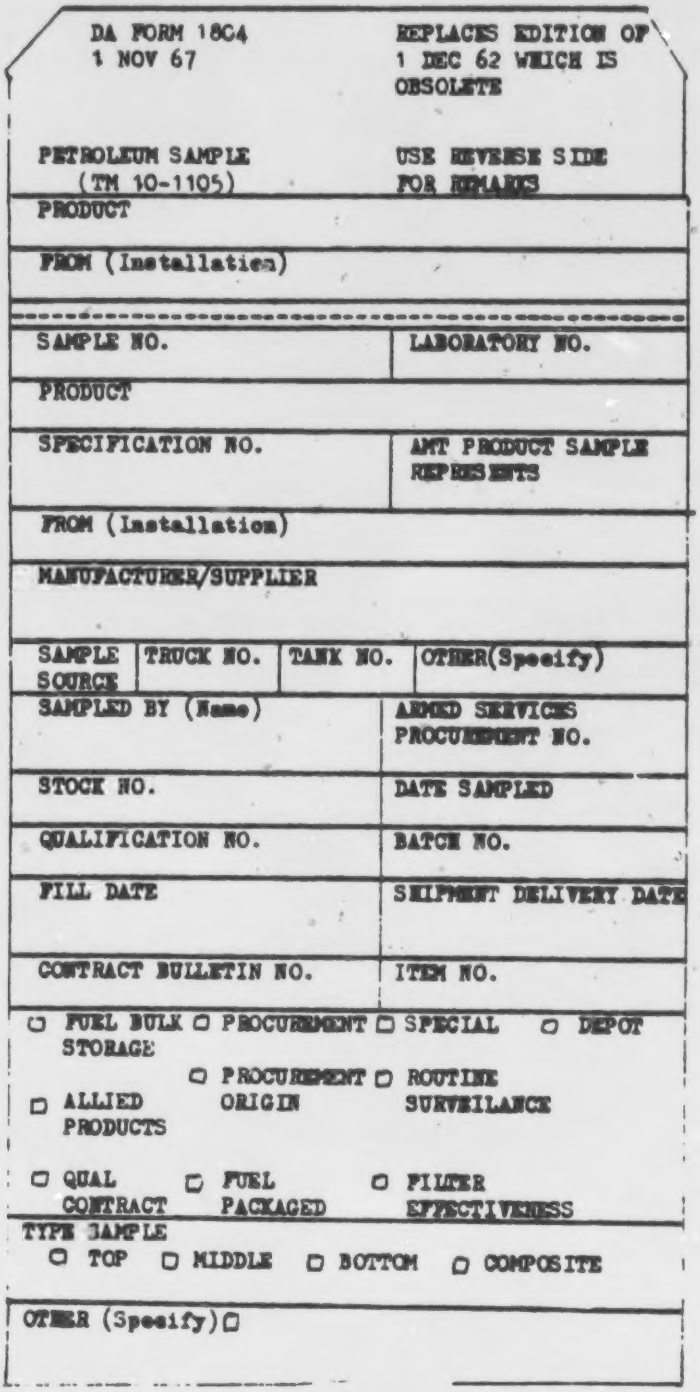
BACON BOMB

WEIGHTED BOTTLE

DROP CORD
HANDLE
CORK
COPPER CASING
LEAD BASE
TOP OPENING
FINGER RING
TUBE
LEG
BOTTOM OPENING
TRIP CORD
DROP CORD
VALVE
CYLINDER WALL
PLUNGER
DROP CORD
CORK
GLASS
LEAD CASING
5B 22-57

FIGURE 1

PETROLEUM SAMPLE TAG



DA FORM 1804 1 NOV 67	REPLACES EDITION OF 1 DEC 62 WHICH IS OBSOLETE
PETROLEUM SAMPLE (TM 10-1105)	USE REVERSE SIDE FOR REMARKS
PRODUCT	
FROM (Installation)	
SAMPLE NO.	LABORATORY NO.
PRODUCT	
SPECIFICATION NO.	AMT PRODUCT SAMPLE REPRESENTS
FROM (Installation)	
MANUFACTURER/SUPPLIER	
SAMPLED BY (Name)	ARMED SERVICES PROCUREMENT NO.
STOCK NO.	DATE SAMPLED
QUALIFICATION NO.	BATCH NO.
FILL DATE	SHIPMENT DELIVERY DATE
CONTRACT BULLETIN NO.	ITEM NO.

SAMPLE SOURCE	TRUCK NO.	TANK NO.	OTHER(Specify)

☐ FUEL BULK STORAGE ☐ PROCUREMENT ☐ SPECIAL ☐ DEPOT

☐ ALLIED PRODUCTS ☐ PROCUREMENT ORIGIN ☐ ROUTINE SURVEILANCE

☐ QUAL CONTRACT ☐ FUEL PACKAGED ☐ FILTER EFFECTIVENESS

TYPE SAMPLE

☐ TOP ☐ MIDDLE ☐ BOTTOM ☐ COMPOSITE

OTHER (Specify) ☐

OUTAGE GAGE SHEET
(USING OUTAGE TAPE AND BOB)

For use of this form, see TM 10-1101, the proponent agency is the US Continental Army Command

UNIT 67Th Q.M. CO (PETRL OPER)	DATE 7 JULY 1973	TIME 1700 HRS
LOCATION TANK FARM #2 INCHON, KOREA	API GRAVITY 71.5	☐ OPENING ☐ CLOSING ☒ INVENTORY

TANK NO. 10	NOMINAL TANK CAPACITY 500 BBL	PRODUCT AND GRADE AVGAS 115/145

LINE NO.	PROCEDURE	LINEAR READING	VOLUME (Gallons)
1	Tape reading	0' 10"	
2	Bob reading	0' 1⅓"	
3	Reference height	8' 1⅞"	
4	Outage (line 1 plus line 2)	0' 11⅓"	
5	Innage (line 3 minus line 4)	7' 2¾"	19,692
6	Bottom sediment and water	0' 3⅛"	709
7	Net volume of product, uncorrected for temperature (line 5 minus line 6)		18,983
8	Average temperature	68° F	
9	Multiplier	.9944	
10	Net quantity of product at 60°F. (US gallons) (line 7 multiplied by line 9)		18,877

REMARKS (Include sample number)

NAME AND GRADE OF OPERATIONS OFFICER (Print) JOHN L. BROWN, CPT	NAME AND GRADE OF GAGER (Print) WILLIAM J. KELLY SGT
SIGNATURE OF OPERATIONS OFFICER John L Brown	SIGNATURE OF GAGER William J Kelly

DA FORM 3853-3
1 May 72

INNAGE GAGE SHEET
(USING INNAGE TAPE AND BOB)
For use of this form, see TM 10-1101, the proponent agency is the
US Continental Army Command

UNIT 67TH QM CO (PETRL OPER)
DATE 7 JULY 1975
TIME 1700 HRS
LOCATION TANK FARM #2
INCHON, KOREA
API GRAVITY 71.5
☐ OPENING
☑ CLOSING
☐ INVENTORY
TANK NO. 10
NOMINAL TANK CAPACITY 500 BBL
PRODUCT AND GRADE AVGAS 115/145

LINE NO.	PROCEDURE	LINEAL READING	VOLUMETRIC EQUIVALENT (Gallons)
1	Tape reading (innage)	7'2 3/4"	19,692
2	Bob reading (bottom sediment and water)	0'3 1/8"	709
3	Net volume of product, uncorrected for temperature (line 1 minus line 2)		18,983
4	Average temperature	63°F	
5	Multiplier	.9944	
6	Net quality of product at 60°F (U.S. gallons) (line 3 multiplied by line 5)		18,877

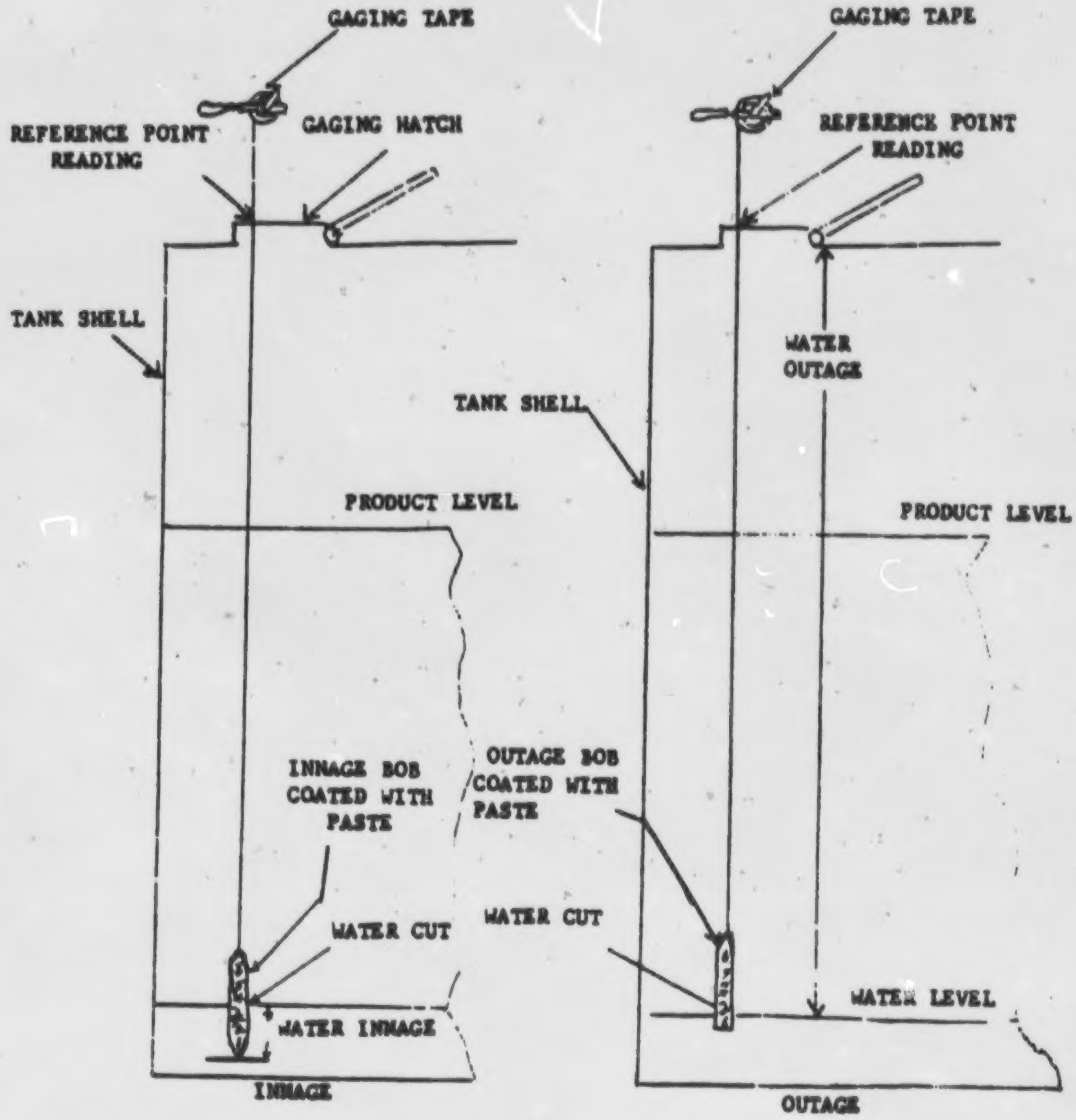
REMARKS (Include sample number)

NAME AND GRADE OF OPERATIONS OFFICER (Print) JOHN L. BROWN, CPT
NAME AND GRADE OF GAGER (Print) WILLIAM J. KELLY, SGT
SIGNATURE OF OPERATIONS OFFICER John L. Brown
SIGNATURE OF GAGER William J. Kelly

FORM 3853-1
1 May 72

535

WATER GAGE DIAGRAM


GAGING TAPE
REFERENCE POINT READING
GAGING HATCH
TANK SHELL
PRODUCT LEVEL
INNAGE BOB COATED WITH PASTE
WATER CUT
WATER INNAGE
INNAGE
GAGING TAPE
REFERENCE POINT READING
WATER OUTAGE
TANK SHELL
PRODUCT LEVEL
OUTAGE BOB COATED WITH PASTE
WATER CUT
WATER LEVEL
OUTAGE

STRAPPING CHART
500 BBL TANK

	INN	GAL		INN	GAL		INN	GAL
0'	1"	227	3'	0"	8172	6'	0"	16344
	2"	454		1"	8399		1"	16571
	3"	681		2"	8626		2"	16798
	4"	908		3"	8853		3"	17025
	5"	1135		4"	9080		4"	17252
	6"	1362		5"	9307		5"	17479
	7"	1589		6"	9534		6"	17706
	8"	1816		7"	9761		7"	17933
	9"	2043		8"	9988		8"	18160
	10"	2270		9"	10215		9"	18387
	11"	2497		10"	10442		10"	18614
				11"	10669		11"	18841
1'	0"	2724	4'	0"	10896	7'	0"	19061
	1"	2951		1"	11123		1"	19295
	2"	3178		2"	11350		2"	19522
	3"	3405		3"	11577		3"	19749
	4"	3632		4"	11804		4"	19976
	5"	3859		5"	12031		5"	20203
	6"	4086		6"	12258		6"	20430
	7"	4313		7"	12485		7"	20657
	8"	4540		8"	12712		8"	20884
	9"	4767		9"	12939		9"	21111
	10"	4994		10"	13166		10"	21338
	11"	5221		11"	13393		11"	21565
2'	0"	5448	5'	0"	13620	8'	0"	21793
	1"	5675		1"	13847		1"	22019
	2"	5902		2"	14074			
	3"	6129		3"	14301			
	4"	6356		4"	14528			
	5"	6583		5"	14755		1/8"	28.375
	6"	6810		6"	14982		1/4"	56.750
	7"	7037		7"	15209		3/8"	85.125
	8"	7264		8"	15436		1/2"	113.500
	9"	7491		9"	15663		5/8"	141.875
	10"	7718		10"	15890		3/4"	170.250
	11"	7945		11"	16117		7/8"	198.625

NOTE: Should be used for Instructional Purposes only.

SAMPLING AND GAGING

PRACTICAL EXERCISE

Introduction

If there is one task required of a Petroleum Supply Specialist that demands a high degree of professionalism it is sampling and gaging. Issues, receipts, and accounting are impossible without accurate gages. Laboratory test results are meaningless without truly representative samples. Thousands of dollars worth of expensive machinery and in some cases, lives are dependent on accurate sampling and testing.

In this PE you will apply what you've learned already in sampling and gaging. When you complete this PE you will be given an examination to determine that you can take an accurate gage and representative samples. Follow your instructions closely.

TURN THE PAGE

PROPONENT DEPARTMENT: Petroleum and Field Services

September 1976

Part I

SAFETY

Below are some general safety rules you must remember and follow. Study these rules carefully before you continue this exercise.

1. Always gage tanks using the buddy system of two men working together.

2. Never wear a hat or carry loose objects in shirt pockets when working over an open hatch.

3. Always ground yourself before climbing a tank. (Stand on ground and touch the tank.)

4. Never stand on top of the storage tank while gaging.

5. Stay upwind from open hatches as much as possible to avoid inhaling vapors.

6. Never get in a hurry. Safety and accuracy are most important.

7. Never climb a tank during a storm.

After you have studied these rules carefully, turn the page and continue.

Without turning back to page 2 write down all seven rules to remember.

1.

2.

3.

4.

5.

6.

7.

After you have written all seven rules turn back to page 2 and compare your answers, then continue to page 4.

Part II

You are now ready for the practical exercise. Follow your steps closely.

1. Find yourself a Buddy who is also ready for this exercise.

2. Go to the Supply Room in the Petroleum Training Facility and draw the following items of equipment.

   A. Gagers Kit (check for gasoline and water paste).

   B. Four or five rags.

   C. Weighted copper beaker thief.

   D. Bacon bomb.

   E. Weighted glass bottle.

   F. One gallon sample can each.

   G. Two sample tags each.

   H. Safety harness and rope.

3. Check all equipment to insure it is in good operating condition.

4. Be sure you have pencil and paper.

Having prepared yourself, go to Bleacher #3 in the Petroleum Training Facility with all your equipment.

(Turn the Page)

PART III

GAGING

Before continuing with next step check with the instructor in the area to be sure you won't be conflicting with other activities there. Then go to Tank #6.

REMEMBER YOUR SAFETY RULES

NOTE: Read pages 5 thru 11 then come back to page 5 and follow instructions on those pages.

1. Climb onto the catwalk around Tank #6 taking all your equipment with you except the safety harness and rope. (The safety harness and rope is used for the 3,000 barrel tanks with vertical ladders.)

2. Select a hatch on the upwind side of the tank and lay out your equipment neatly and at least two feet from the hatch.

3. Beside the hatch you see the "Reference Height" stenciled on top of the tank. Open the hatch cover and look inside the tank. You should be able to approximate how many feet of fuel are in the tank.

4. The next step is to insert the thermometer in the correct place. (Remembering your text portion you know that only one depth reading is required for depths under ten feet.) Climb on top of the tank and take your cupcase thermometer out to the center hatch cover.

5. Check the rope on the cupcase to make sure it is tied firmly and the rope is in good condition. Check also the thermometer to make sure it is not broken or the mercury separated. Look at the scale on the thermometer to make sure you can read it. (If you have problems check with your instructor.)

6. Open the center hatch cover and lower the cupcase until it just touches the surface of the fuel in the tank. Remember your estimate of the depth of fuel in the tank and lower the thermometer half that distance. The bulb of the thermometer should be very near to the center of product in the tank. Wrap the rope around the hatch cover hinge several times to secure it in place.

TURN THE PAGE

7. Return now to the catwalk beside the hatch you are going to use for gaging.

8. Take out the innage tape and bob. Make sure the bob is securely fastened to the tape. Reel out a couple feet of tare and look closely at the scale to be sure you can read it then wind all but about six (6) inches back on the reel.

9. Lay the reel on tank.

10. Squeeze out a small amount of "Water Finding Paste" on your index finger. Then spread a narrow line of paste on the side of the bob from end to end.

11. Wipe off your fingers with a clean rag.

12. Open the tube of gasoline paste and lay it near the hatch.

13. Grasp the gaging tape handle with your left hand and keep your thumb against the tape. (Your thumb acts as a brake for the tape.) Make sure the crank handle is on the right so you will be able to reel in the tape.

14. Lower the bob into the hatch about six (6) inches and stop. Hold the tape against the edge of the hatch in the "Reference point" slot with your right hand. Make sure the handle of the reel is straight out so it doesn't bang your fingers when it turns.

"See illustration on next page."

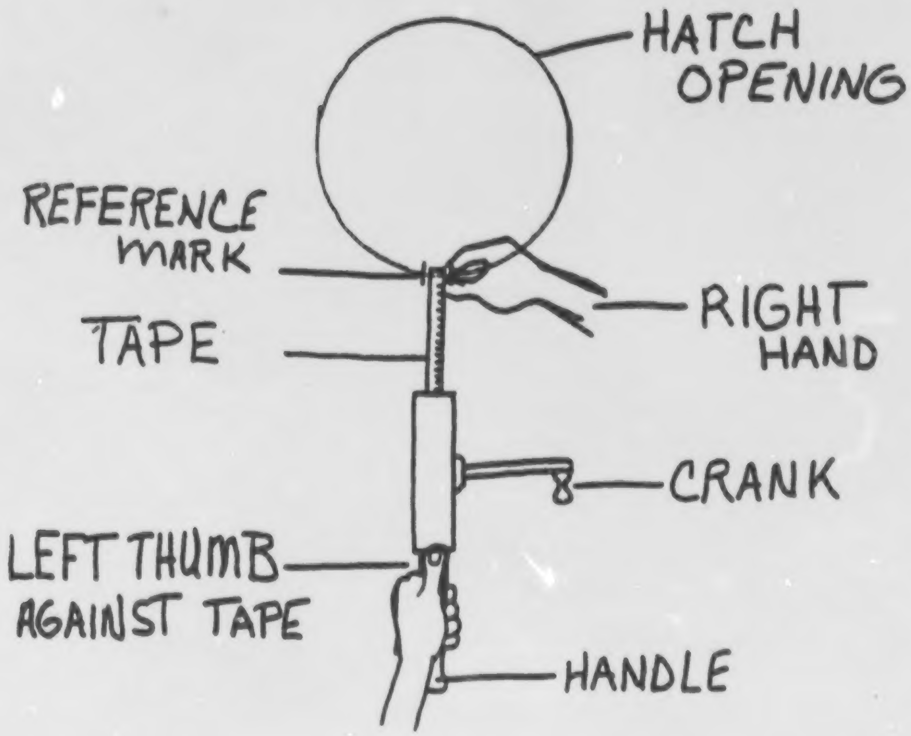

HATCH OPENING
REFERENCE MARK
RIGHT HAND
TAPE
CRANK
LEFT THUMB AGAINST TAPE
HANDLE

FIGURE #1

15. Hold the tape firmly against the hatch with your right hand, pull about two feet off the reel at a time with the left hand. Holding the tape on the reel with the left thumb, so it doesn't slip, let the tape slide under the fingers of the right hand thus lowering the bob.

16. Repeat "Step 15" slowly until the tip of the bob just barely touches the top of the fuel in the tank.

17. Read the tape at this point. (see figure 2 on page 9)

18. Subtract the reading you get at this point from the "Reference Height." This will tell you very closely what the "Estimated Innage" is.

19. Repeat "Step 15" until the tape reads about one foot less than the "Estimated Innage" at the Reference Point and stop.

20. With your right hand put a small amount of "Gasoline Finding Paste" on your right index finger. Spread this paste thinly and evenly on the tape from one foot below the "Estimated Innage" to one foot above the "Estimated Innage."

21. Continue on with "Step 15" slowly until the bob just barely touches the bottom of the tank. At this point hold the tape very firmly with the right hand so that it doesn't move for at least 30 seconds.

NOTE: You can check your accuracy by looking at the tape at the "Reference Point". It should read the same as the stenciled "Reference Height."

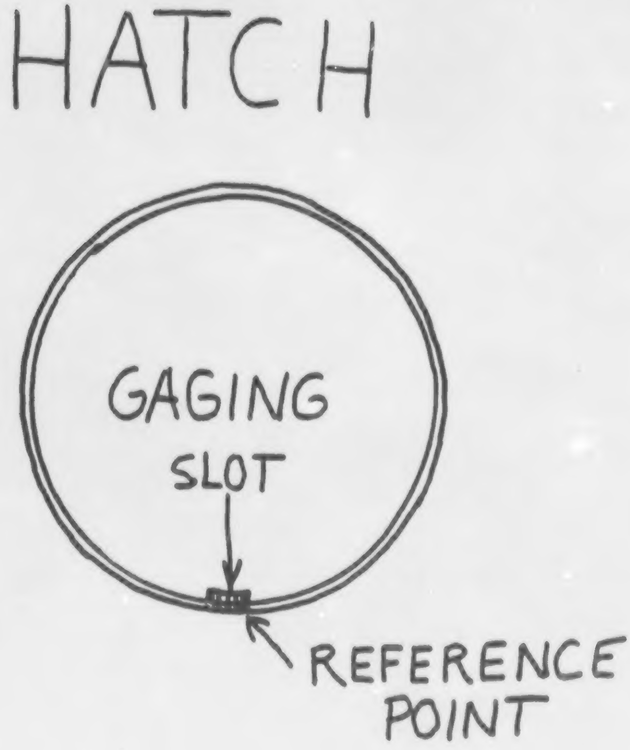

HATCH
GAGING
SLOT
REFERENCE
POINT

FIGURE #2

22. With your left hand pull the tape up sharply about one foot. Do not let it slip back down.

23. With your right hand crank up the tape until you can read the "Gasoline Finding Paste" cut. This paste, as you know, is blue. Where the fuel is touching it, it will turn very pale blue to white. If you followed directions closely you should find a sharp, easy to read cut on the paste.

24. Read the tape scale at this cut and you have the "Gross Innage" or "Total Innage" for the tank. Write this reading down on a piece of paper.

25. Wipe the paste off the tape with a rag.

26. Wind up the rest of the tape until you can get the bob out. Most bobs do not have a scale on them so you will have to lay it beside the tape to measure the water cut depth. The "Water Finding Paste" is pink and where water touches the paste it will turn white. If you followed directions closely you should find a sharp cut between the white and pink. Measure the length of the white portion accurately and write it down on paper. This is the "BS&W (Bottom Sediment and Water).

27. Unwind the tape on top of the tank enough so you can take a clean rag and wipe off all fuel, paste and water from the tape. Clean the tape and bob and rewind it.

28. Repeat steps 9 thru 15 and 19 thru 27 until you are sure of your gage readings.

NOTE: Remember that all gage readings must be accurate to 1/8 inch.

29. Your thermometer has been in the tank long enough by now. Go back to the center hatch and pull the thermometer up and read it quickly and accurately.

30. Empty the cupcase into the tank. Then use a rag to wipe off the fuel. Unwrap the cord from the hatch cover hinge. Coil the cord around the cupcase thermometer and return all gaging equipment to the gaging kit.

Repeat any and all steps preceding this point in the PE until you are sure you understand them. If you have any problems see your instructor. When you are confident you can gage a storage tank, turn the page and continue this PE.

PART IV

ALL LEVEL SAMPLE

During this PE you will only have to take two types of samples: the all level sample and the bottom sample. You will learn two ways to take the all level sample. Read pages 12 thru 16 then follow all instructions on those pages.

In tank farm operations throughout the Army the most common and routine sample taken is the one gallon All Level Sample. Follow the steps closely and if you have any problems always see your instructor.

1. Take the rope from around the Weighted Copper Beaker Thief. Check the rope for good condition and make sure that one end is tied firmly to the sample thief.

2. Tie the loose end of the rope to the hatch cover. Then coil the rope loosely beside the hatch so it won't get tangled when lowering and raising the sample thief.

3. Make sure the cork is firmly attached to the rope about six inches above the sample thief.

4. Do not put the cork in the sampler.

5. Lower the sampler about two feet below the surface of product in the tank and allow it to fill about half full then pull it out and pour the fuel back in the tank. This is called "Rinsing the Sample Thief".

NOTE: When the fuel in the tank is suspected of being contaminated all rinses should be put in a slop can and not back in the tank.

6. Rinse the sample thief twice.

7. Again withdraw half a thief full of fuel but this time pour the fuel in the sample can and rinse the can. Again pour the fuel back in the tank. Do this step twice. This is called "Rinsing the Sample Can".

NOTE: Always keep the lid on the sample can except when pouring fuel in or out of it.

Having rinsed both the sample thief and can twice you are ready to take your sample.

8. Put the cork firmly in top of the sample thief.

9. Lower the sample thief gently to the bottom of the tank without popping the cork out.

10. Raise the sample thief about one foot off the bottom. Let the sample thief drop then jerk the cork out at the instant the sample thief touches bottom. Without stopping begin pulling out the sample thief at a steady speed until it comes out of the surface of the fuel in the tank. Then quickly pull it out of the tank. When the sample thief emerges from the fuel it must be at least 80% full but not more than 90% full.

NOTE: Even experts sometimes have a problem with step 10 but with practice you will be able to do it. (See figure 3 on page 14.)

550

WEIGHTED COPPER BEAKER THIEF

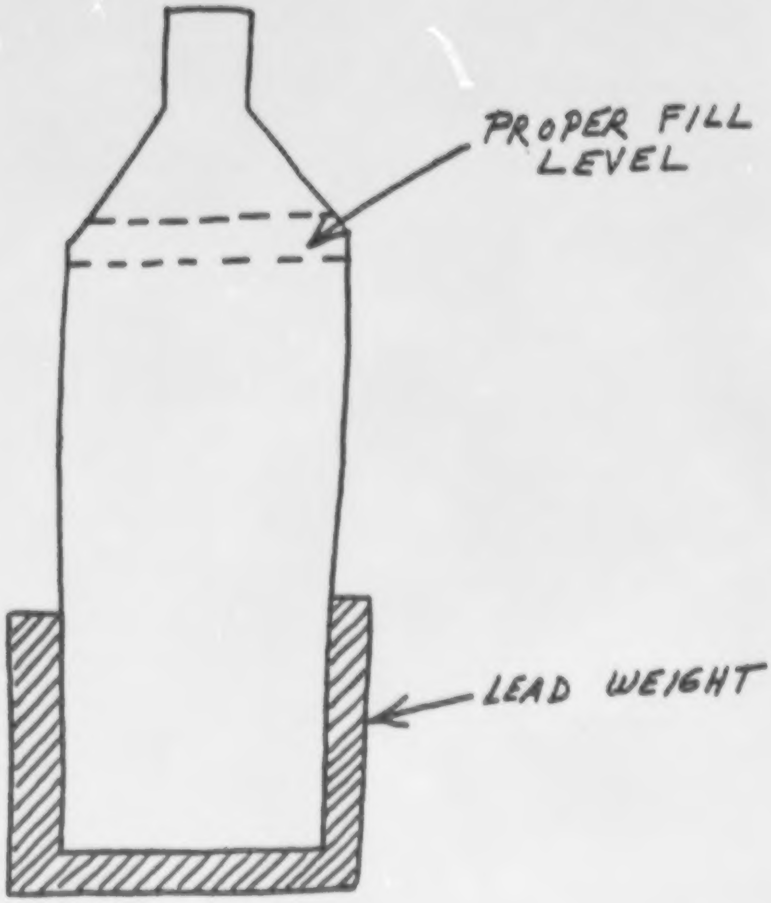

PROPER FILL LEVEL
LEAD WEIGHT

Figure #3

11. Quickly transfer the fuel from the sample thief to the sample can without spilling it then close the sample can.

12. Repeat Steps 8 thru 11 until the sample can is at least 85% full but not over 90% full.

13. Wipe the sample thief, rope and can with a clean rag, then clean up any spills.

14. Fill out one of your sample tags and tie it to the can.

You have now taken a proper ALL LEVEL SAMPLE. Practice the different steps until you are sure you can do it properly. When you are sure of yourself continue to the next page.

552

PART V

WEIGHTED GLASS BOTTLE

The "Weighted Glass Bottle" sample thief is commonly used when a whole gallon is not needed. For example on ships or barges where you take an all level sample from each compartment then make a composite sample using a little fuel from each compartment.

To use this sample thief you would follow these steps.

1. Make sure the bottle is secure in the holder.
2. Tie the loose end of the rope to the hatch cover.
3. Rinse the bottle the same as you rinsed the "Weighted Copper Beaker Thief. "
4. Insert the cork firmly.
5. Lower the thief to the bottom of the tank and take a sample exactly as you did with the "Weighted Copper Beaker Thief". Make sure the bottle is at least 80% full but not more than 90% full when it comes out of the fuel.
6. Quickly put the cap on the bottle.
7. Remove the bottle from the holder and clean the fuel off the bottle and holder.
8. Put sample tag on the bottle.

Again you are not required to take this sample during this PE but it is well to remember the details.

Turn the page

561

PART VI

BOTTOM SAMPLE

The "Bacon Bomb" is used for taking bottom samples. Sometimes a laboratory will request a bottom sample to look for special problems in a storage tank. In rail tank car operations a bottom sample is required of all tank cars.

Read through all of Part VI in this PE then come back and follow the instructions.

1. Unwrap the cord from the "Bacon Bomb" and tie the loose end to the hatch cover.

2. Inspect the sampler for any missing parts and make sure the rope is tied tight.

3. Hold the sample thief in your left hand and press the bottom against the tank roof. The center pin should pop up.

4. With your right hand turn the small wheel on top so that the edge of the small wheel catches the groove in the center pin. If you did this correctly the center pin will stay in the up position when you lift the sample thief up.

5. Lower the sample thief into the tank about two feet below the surface of the fuel.

6. Allow the sample thief to stay there until the bubbles quit coming up.

7. Raise the sample thief about one foot above the surface of the fuel and allow the fuel to drain out of the sample thief.

8. Repeat steps 5, 6 and 7. This will rinse the sample thief twice.

NOTE: When taking a Bottom Sample it is necessary to rinse the sample can. You would use a Weighted Copper Beaker Thief exactly as you did for an All Level Sample. In this PE you won't put the Bottom Sample in a one gallon can so it is not necessary to rinse a can at this time.

9. Pull the Bacon Bomb out of the tank and hold it over the open hatch.

10. Hold the Bacon bomb with your left hand and with your right hand turn the small wheel on top until the center pin drops. The Bacom Bomb is ready now to take a sample.

Turn the Page

NOTE: It is very important that the next step be done right. Before you do this next step take the rope in your right hand and hold the sample thief over the tank roof. Using your right hand only lower the Bacon Bomb so it touches the roof. Watch the center pin. Let enough weight on the roof to push the pin up but not enough to let the Bacon Bomb tip over. Practice this a couple of times and you will get the feel in your right hand.

11. Lower the Bacon Bomb all the way to the bottom of the tank. Let it touch bottom hard enough to open but not enough to tip over.

NOTE: While you are doing this have your buddy remove the glass bottle and take the cap off, ready to receive the sample.

12. Hold the Bacon Bomb against the bottom for 10 seconds.

13. Quickly pull the Bacon Bomb all the way out of the tank and hold it with your left hand over the open hatch.

14. Have your Buddy hold the bottle under the Bacon Bomb.

15. With your right hand grasp the center pin on top of the Bacon Bomb. Very slowly pull the pin up and allow the sample to run out of the Bacon Bomb into the bottle.

16. The bottle should be at least 80% full but not over 90%. If you need more sample, repeat steps 11 thru 15.

17. Put the cap on the sample bottle.

18. Take rags and clean all equipment.

19. Fill out a sample tag and tie it to the bottle.

20. Clean up your equipment and your work area and close the hatch covers.

21. Return to Bleacher #3 with all your equipment and ask the instructor for your first critique.

PART VII

FIRST CRITIQUE

During this critique the instructor will do the following for you.

1. Answer any questions you might have concerning what you have done.
2. Check your samples and tags.
3. Demonstrate the use of the safety belt.
4. Tell you when and show you how to use the additional rope you have.
5. Assign a tank for you to use in Part VII of the PE.

556

PART VIII

During this portion of your PE you will gage a 3,000 barrel tank. Your instructor has assigned a tank for you to gage. Go now to that tank.

1. You and your Buddy will take turns gaging this tank. One of you will climb and gage the tank, the other will write down on a piece of paper the gage results.

2. Put on the safety belt and attach it to the safety pole.

3. Sling the gaging kit over your shoulder and climb the tank.

4. Disconnect safety belt only while taking tank temperature as you will take the gage while standing on the ladder.

5. Place gaging kit on the roof close to the hatch but not in the way of your gaging operation.

6. Gage the tank as you learned in Part III of this PE.

7. Call your readings down to your Buddy.

8. After you finish gaging, assemble your equipment and return to the ground.

9. You and your buddy change places and have him do steps 2 thru 8.

10. If you are not sure of your gages or ability then try again. When you are sure then go to Bleacher #3 and complete the Review on the next page.

565

PART IX

REVIEW

To help you prepare for your exam complete the following exercise.

1. You should never gage a tank during a storm. Which of the following is the best reason for this safety rule?

   a. You are a prime target for lightning.

   b. Wind, rain or snow make climbing more dangerous.

   c. Open hatches during a storm could cause contamination of the fuel.

   d. All of the above.

2. What are the three things you must determine when gaging a tank?

   a. ____________________

   b. ____________________

   c. ____________________

3. What does BS&W stand for?

   ____

4. If your NCOIC asked you to get a routine sample from a tank what kind of sample would you take?

   ____

5. What kind of sample is always taken from a rail car?

   ____

6. How many times is it necessary to rinse a sample can before putting your sample in it?

   ____

7. After your sample can is sealed what are the next two steps?

   a. ____________________

   b. ____________________

Check your answers on the next page. If your answers don't agree then review your work until you are satisfied of the results.

ANSWERS TO REVIEW

1. d
2. a. temperature
   b. gross (or total) innage
   c. BS&W
3. bottom sediment and water
4. all level
5. bottom sample
6. twice
7. a. wipe off sample can and equipment
   b. fill out a sample tag

If you are satisfied with your answers see your instructor for your final critique.

Turn the Page

PART X

FINAL CRITIQUE

During this final critique the instructor will answer any questions you may have. It might be necessary for additional practice. When you and the instructor are satisfied that you are ready for your examination the instructor will give you the examination.

GOOD LUCK!

EXAMINATION

SAMPLING AND GAGING PEE

Instructor will assign a tank to the student and advise him to get a correct gage on the tank. The instructor will specify what type sample the student will take and evaluate the student on the following:

	VALUE	SCORE
1. Sampling		
a. Observe safety precautions	9	
b. Use proper techniques	9	
c. Get good sample	12	
d. Complete sample tag	10	
e. Clean equipment	5	
2. Gaging		
a. Observe safety precautions	9	
b. Use proper technique	9	
c. Gross innage within 1/8 inch	12	
d. Temperature within 1° F	10	
e. BS&S within 1/8 inch	10	
f. Clean equipment	5	

QMS 300.505 PT

NET INNAGE
AND
VOLUME CORRECTION

PROPONENT DEPARTMENT: Petroleum & Field Services

Oct 77

Supersedes QMS 300.505 PT dated Feb 77

INSTRUCTION TO STUDENT

Of all the duties you may be required to perform as Petroleum Supply Specialist, gaging and volume correction will be the most exacting. Once you learn the basic steps you will find it is an easy process to remember, but throughout your career you will learn that trying short cuts never work and accuracy is very important.

The reason behind gaging and volume correction is to find out how much fuel is in any given tank at any given time. Because fuels expand or contract with changing temperatures, gaging (measuring the liquid depth) is only the beginning. If you gaged a tank and found out that you had 5,000 gallons in that tank, at 85°F when the fuel cools off to 60°F you are going to have less than 5,000 gallons. Sixty degrees Fahrenheit is the standard temperature for all petroleum products. Quantities of 3,500 gallons or more should be reported at this temperature. The purpose of this lesson is to show you exactly how this is done.

It will be necessary to use math procedures to obtain an accurate answer. You do not have to be a math genius to complete the problems. If you keep the basic principles covered on the following pages in mind, you should have no problems. You may need help with decimals so read the following four examples. After you have done so and feel that you understand all four examples, go on to Part I of this program.

DECIMALS

1. A decimal number is a fractional part of a whole.

   EXAMPLE: If you have one dollar, you write it like this - $1.00
   The zeros to the right of the decimal point indicates that you have no cents. If you have one dollar and twenty-five cents, you write it like this - $1.25
   The .25 indicates 25 parts of one dollar.

2. You do not change the value of a number by adding a decimal point and zeros.

   EXAMPLE: The number 147 does not change in value by writing it -- 147.000

3. When adding or subtracting decimals or whole numbers keep the decimal point in a straight vertical line for all numbers in the problem and in the answer.

   EXAMPLE: Add 39.52 to 19,483

$$\begin{array}{rr} & 19{,}483.00 \\ + & 39.52 \\ \hline & 19{,}522.52 \end{array}$$

(Remember - You don't change the value of 19,483 by adding a decimal & two zeros.)

Notice how the decimal points are in a straight vertical line. This same rule holds true for subtraction problems. The decimal point is the key factor in setting up the problem.

4. When multiplying decimals the set-up is a little different. The decimal point does not become a factor until after you have worked the problem.

EXAMPLE: Multiply 1,504 by .334

```
  1,504.5    (Notice the decimal
x    .334    points are not in
   60180     line.)
  45135
 45135
 502.5030
```

When you get your answer, count the number of decimal places in the original problem. In this case you have four. Start at the right of your answer and count off (to the left) the same number of decimal places and put in your decimal point.

If you understand the four examples you just went over, go to Part I and continue with the rest of the lesson. If not, review these examples or ask your instructor for help.

PART I

INTRODUCTION

You have already learned how to gage a storage tank. When you gaged the tank you determined four separate things:

1. Innage (in feet and inches)
2. BS&W (in feet and inches)
3. Temperature (observed or average)
4. APT Gravity

The gage readings were accurate to the nearest 1/8 inch. Now we are going to show you how to use the information you obtained from gaging to correct the volume to 60°F.

OBJECTIVES

Given a strapping chart, ASTM Table #6, API Gravity at 60°F and gaging information the student will be able to:

1. Convert feet and inches measurements into gallons.
2. Find the net volume uncorrected.
3. Determine the conversion factor.
4. Find the net volume corrected to 60°F.
5. Report correctly the net volume at 60°F.

As you can see by the objectives, there are five basic steps involved in volume correction. We will cover each step in detail but first lets discuss a key word used in volume correction. What does the word "innage" mean to you? According to DA Manual TC 10-2, innage is "the height or volume of liquid in a storage tank, as measured or gaged from the bottom of the tank to the top of the liquid." In other words, innage is the total amount of liquid in a storage tank. When you think of innage think TOTAL. The two words mean the same thing. The key thing to remember is that the BS&W is included in the innage. Other terms that mean the same thing as innage are: total measured quantity, and gross volume. If you still don't understand what innage is check with your instructor. It is very important that you know the meaning of this word.

PART II

Now, lets take each one of our objectives and cover it in detail. Remember, volume correction is a step-by-step process. If you follow the steps in proper sequence, you will get the correct answers.

STEP 1: Change feet and inches into gallons. - - To do this we need a strapping chart. A strapping chart is made up for each different type of storage tank. It is a simple way of changing feet and inches into gallons. There is an example of a 500 barrel strapping chart included in this lesson on page 46. Remove the strapping chart and place it beside your lesson text.

The strapping chart is divided into three columns and the columns into blocks. Each block represents one foot of liquid broken down in inches. It shows how many gallons each inch equals. Look at the chart now to familiarize yourself with it.

To determine the number of gallons for fractions of an inch, we use the block at the bottom right corner of the chart. Look at this block now. Notice that the fractional parts of a gallon are listed in decimal form.

You are now ready to put the chart to work. You gaged a tank and determined the following:

a. Innage = 4' 5 3/8"

b. BS&W = 2 1/4 "

c. Temperature = 65°F

You don't need the temperature at this time so disregard it for now.

Determine the INNAGE measurement using the strapping chart. To do this find first 4' 5" in Column #2 and you see it is 12,031 gallons. Next, in the bottom right corner find 3/8" and you see it is 85.125 gallons. You add these together to get your innage.

4' 5" = 12,031.000
3/8" = 85.125

Innage = 12,116.125 gallons

NOTE: By adding .000 to 12,031 you did not change the value. Make sure your decimal points are lined up properly.

You have now determined how many gallons of innage you have. Remember, innage is the TOTAL amount of liquid in the tank.

You now have to find the BS&W in gallons. You find this the same way you found the innage. First find 0' 2" in Column #1 and you see it is 454 gallons. Now find 1/4" in the bottom right corner and you see it is 56.750 gallons. Add these two together.

2" = 454.000
1/4" = 56.750

BS&W = 510.750 gallons

Now you know how many gallons of innage you have and how many gallons of BS&W you have. This completes the first step in our volume correction procedures. To make sure you understand how to use the strapping chart do the exercise that follows.

PRACTICAL EXERCISE - OBJECTIVE #1

Using the strapping chart, scratch paper and pencil, convert the following gage readings into gallons.

1. (a) Innage - 5' 3 3/4"
   (b) BS&W 6 1/2"

(a) ANSWER________________gals

(b) ANSWER________________gals

2. (a) Innage - 4' 4 1/2"
   (b) BS&W - 2"

(a) ANSWER________________gals

(b) ANSWER________________gals

3. (a) Innage - 7' 5 1/8"
   (b) BS&W - 3/4"

(a) ANSWER________________gals

(b) ANSWER________________gals

ANSWERS TO EXERCISE #1

1. (a) 14,471.250 gallons
   (b) 1,475.500 gallons

2. (a) 11,917.500 gallons
   (b) 454 gallons

3. (a) 20,231.375 gallons
   (b) 170.250 gallons

If you did not get the correct answers, review your work, if you still have problems, consult your instructor. Once you can use the strapping chart properly, you are ready to go to step 2 which is to find the net volume uncorrected.

STEP 2: Find the Net Volume Uncorrected

This step is simple but you have to know what we are talking about first. What is net volume uncorrected? Net volume is the amount of good fuel in a storage tank. Uncorrected means that it is the amount of fuel at the observed temperature. You can already determine how many gallons of innage or total liquid you have and how many gallons of water or BS&W. The water at the bottom of the tank cannot be used for fuel, so therefore, you must eliminate it from your calculations. By doing this you have the net volume uncorrected. To word it differently, to find the net volume uncorrected, subtract the BS&W from the innage. After you have changed both to gallons of course. Let's see how it works in a practical situation. After converting your innage you found that you had 24,376.500 gallons. Also your BS&W equaled 343.500 gallons. To find the net volume uncorrected we must subtract.

Innage = 24,376.500
BS&W = - 343.375
24,033.125 gallons

Net volume is always reported to the nearest gallon. So, in this case our net volume uncorrected is 24,033 gallons.

If you understand how to find the net volume uncorrected do the exercise that follows. If you have trouble, consult your instructor.

PRACTICAL EXERCISE - OBJECTIVE #2

Find the net volume uncorrected for the following problems.

1. Innage = 14,471.250 gallons
   BS&W = 1,475.500 gallons

ANSWER____________________ gals

2. Innage = 11,917.500 gallons
   BS&W = 454 gallons

ANSWER____________________ gals

3. Innage = 20,231.375 gallons
   BS&W = 170.250 gallons

ANSWER____________________ gals

ANSWERS TO EXERCISE #2

1. 12,996 gallons - net volume uncorrected
2. 11,464 gallons - net volume uncorrected
3. 20,061 gallons - net volume uncorrected

Did you remember to round off your answers to the nearest gallon? If you did not get the correct answers review your work. If you still have problems, consult your instructor.

At this point you have learned the first two steps in volume correction. Before you go on to the third, fourth, and fifth steps, let's review and cover some areas that might give you trouble.

When reading your strapping chart, a common mistake is confusing feet and inches. Remember, feet are indicated by one mark (') above the number. Inches are indicated by two marks (") above the number.

Another problem area that has been identified by past experience is adding and subtracting decimal numbers. If this gave you trouble, review the math examples at the beginning of this text. If you are still confused, check with your instructor.

Make sure you understand the term "innage" and how to find the net volume uncorrected.

STEP #3: Determine the Conversion Factor.

One of the greatest problems in handling petroleum products is accounting for the exact quantity of each product handled, stored or shipped. Quantities of fuel change with temperature variation. Since it would be impractical to build systems to maintain products at a constant temperature, a method has been devised to convert products to a standard temperature for volume determination. This is done by a conversion factor which is used to convert a volume of product at an observed temperature to 60°F.

You might ask yourself why 60°F? The American Petroleum Institute has found that certain petroleum products are stable at 60°F. In other words, the product is not expanded or contracted at that temperature. Therefore, 60°F is the most accurate temperature for recording the volume of product.

The American Society of Testing Materials has devised several methods for this conversion. This lesson will teach you how to use petroleum conversion tables - Table 6. You will not be concerned with the other methods at this time.

In order to bring the military and the worldwide petroleum industry together and have both use the same system of volume measurement, Table 6 has been adopted as the standard.

This conversion will be used on all inventories you will prepare. Allowable losses or gains will be calculated on volumes based on Table 6 conversions. Because of these it is very important to you to become highly proficient with Table 6.

576

STOP

Ask at the Control Desk to show the TV film on volume correction at this time. After seeing the film continue this text.

This portion of your lesson involves learning how to use Table 6. Since it is impossible to memorize this table, you will be required to have this table available to you. For this lesson you will find Table 6 attached as Inclosure 1.

Turn to Table 6 on page 29 at this time and let's see how it is set-up. Look at page 30 of the table. Notice that the API degrees are listed across the top of the table. The numbers run from 30 to 39. If you look at the extreme left hand column you will see the observed temperature degrees from 0 to 50. To use Table 6 properly you simply line up the API degrees with the observed temperature degrees. This gives you the conversion factor.

EXAMPLE - API = 32°

Observed temperature = 46°

Find 32° at the top of the chart. Find 46° in the left hand column. By reading down and across you find the conversion factor is 1.0061 for this problem.

As you can see, using Table 6 is fairly easy but there are other key factors you must learn before you move on.

Why is the API gravity important in volume computations? This question can best be answered with another question. What does the API tell you about a product? If you remember from your class on visual examination the API gravity measures the weight or thickness of a petroleum product. You have heard the expression "blood is thicker than water." The same holds true for petroleum products. Each different product has a different weight or thickness. MOGAS is considered a light product and crude oil is a heavy product and the API gravities of the two products are different. How does this relate to volume correction? The answer to this is expansion (and/or contraction). The lighter a product the more it is effected by changes in temperature. Heavy products will not expand or contract as much as lighter product. This is why you must know what the API gravity of the product is before you can do volume correction.

Refer again to page 30 of Table 6. Look at the top of the page where the API degrees are located. Notice that they are listed in whole degrees only. For example: 30, 31, 32, 33, etc. It is very rare to have an API listed in whole degrees. Normally, the API is in a decimal form. For example: 30.6, 33.4, 37.5, etc. To use Table 6 properly, you must round off the API to the nearest whole degree. Remember also that API gravity must be at 60°F.

To round to whole degrees you will use the rounding rules taught in the following paragraphs.

(a) Values of less than .5 degrees will be dropped. For example - 43.1, 43.3, 43.4 will round off to 43.0°.

(b) Values greater than .5 degrees will be rounded up to the next higher degree. For example - 61.6, 61.7, 61.8, 61.9 will round off to 62.0°.

(c) Values of .5 exactly will round to the nearest even whole number. For example - 43.5 will become 44.0; 44.5 will become 44.0.

Pay particular attention to rule (c). You probably haven't used it before. It is a more accurate way of rounding and it is being taught in some school systems.

At this point you are ready to use Table 6. The practical exercise that follows will give you practice in using this table.

CAUTION!!. - The most common error in using Table 6 is confusing the API degrees with the temperature degrees.

PRACTICAL EXERCISE - OBJECTIVE #3

Using Table 6 locate the conversion factor for the following:

A.	44.1° API @ 60°F	Observed temperature 58°F
B.	58.4° API @ 60°F	Observed temperature 79°F
C.	68.5° API @ 60°F	Observed temperature 79°F

ANSWERS TO PRACTICAL EXERCISE #3

A. The factor is 1.0010

B. The factor is 0.9885

C. The factor is 1.0128 - Did you remember the rounding rule?

The biggest problem you might have when using Table 6 is confusing the API with the temperature. Remember, the API degrees are listed across the top of the table and the temperature degrees are listed down the left hand column.

At this point you should be able to choose any API gravity at any temperature and locate the conversion factor. If you are having difficulty, go back and re-read your program and practice locating different conversion factors. This step is vitally important for accurate results.

STEP 4: Find the net volume corrected to $60^{o}F$. Before discussing this step lets review the other steps you have learned. The first step was changing your feet and inches into gallons. The second step was finding the net volume uncorrected and the third step was locating the conversion factor.

To find the net volume corrected to $60^{O}F$ you multiply the conversion factor from Step 3 times the net volume uncorrected from Step 2. The answer you will get is the amount of good, usable fuel you have at $60^{O}F$. For example, if you have 500,000 gallons of fuel at 53^{o} temperature with an API gravity of 44^{o} the calculation is as follows:

1.0035 X 500,000 gallons = 501,750 gallons

You may continue if you understand this example.

PRACTICAL EXERCISE - OBJECTIVE #4

This is a practical exercise. You are working on your monthly inventory report and find the following information available to you:

PRODUCT	API GRAVITY	TEMPERATURE	NET VOLUME UNCORRECTED
Diesel Fuel	39.6	76°F	481,641 gallons
JP-4	52.5	77°F	1,246,781 gallons
MOGAS	67.3	76°F	3,841,593 gallons

Find the conversion factor and correct the volume of each product.

ANSWERS TO EXERCISE #4

Diesel Fuel - Round off API Gravity to 40° and locate the conversion factor of .9924. Then multiply the factor times the net volume uncorrected. The problem would be set up like this:

```
      481,641
    X   .9924
     1926564
     963282
   4334769
  4334769
477,980.5284   =   477,981 gallons - net volume corrected
```

JP-4 - Round off API to 52° (remember the rounding rule) and locate the conversion factor .9905. Again multiply as follows:

1,246,781 gallons x .9905 = 1,234,937 gallons corrected

MOGAS - Round off API to 67° and find the conversion factor .9893. Multiply the net volume uncorrected by the conversion factor and find a corrected volume of 3,800,488 gallons.

If you had difficulty with these problems, review your mathematics and pay particular attention to the rounding rule.

You are now ready to go to the final step in volume correction.

STEP 5 - Report correctly the net volume at 60°F. During this phase you will learn the correct way to report the corrected volumes you find. The two methods you will learn are interchangable and will be used by both the military and the petroleum industry.

Once you have made your volume corrections it is important that you report your results in the proper manner. This insures that whoever reads your report knows that the conversion to 60°F has been made. Later lessons will further impress upon you the importance of this reporting procedure.

You can report your results in two ways. The first is the preferred method for formal reports, but you will find the other used throughout the petroleum industry.

A corrected volume of 1,000,000 gallons will be reported as 1,000,000 gallons at 60°F.

You will also see it reported as 1,000,000 gallons corrected.

You should have little difficulty with this portion of your lesson. If you do not understand these reporting procedures, contact your instructor. If you understand the five basic steps of volume correction, move on to the self-evaluation item.

SELF EVALUATION

At this point you should be able to make volume corrections from an observed temperature to a volume at 60°F.

In the following situation you have just gaged a 500 barrel storage tank and found the following information:

INNAGE = 5' 3 1/2"

BS&W = 2 3/4"

OBSERVED TEMPERATURE = 75°F

API GRAVITY = 37.4°

Using the knowledge you have gained, the strapping chart and Table 6, find and correctly report the corrected volume.

ANSWER TO SELF EVALUATION ITEM

STEP 1 - Convert innage and BS&W measurements into gallons

5' 3" = 14,301
1/2" = + 113.500
14,414.500 gallons

2" = 454
3/4" = + 170.250
624.250 gallons

STEP 2 - Subtract the BS&W from the innage to get the net volume uncorrected.

14,414.500 gallons - innage
- 624.250 gallons - BS&W
13,790.250

13,790 (rounded off) - net volume uncorrected

STEP 3 - Round off API to 37° and look up the conversion factor of.9932.

STEP 4 - Multiply:

13,790
X .9932
27580
41370
124110
124110
13696.2280

STEP 5 - You have 13,696 gallons at 60°F or 13,696 gallons corrected.

Now, you should be ready to take the examination. Be sure you read each question carefully. The examination is designed to test your ability to do each step either separately or in conjunction with one or more of the other steps. Contact your instructor at this time to take the examination.

TABLE 6

REDUCTION OF VOLUME TO 60°F AGAINST API GRAVITY AT 60°F

This table gives the factors for converting oil volumes observed at temperatures other than 60°F to the corresponding volumes at 60°F for values of API gravity in the range 0 to 100°API.

It is emphasized that the volume correction factor in this table makes no allowance for the thermal expansion of tanks and other types of containers.

> **This table must be entered with API gravity values at 60°F and volumes measured at Fahrenheit temperatures.**

EXAMPLE

What is the volume at 60°F of 63,162 U.S. gallons at 34°F of an oil whose API gravity at 60°F is 64.80?

Enter the table in the column "API Gravity at 60°F," headed 64°API, and note that against an "Observed Temperature" of 34°F the factor is	**1.0168**
Likewise, from the column headed 65°API, note that for the observed temperature of 34°F the factor is	**1.0170**
This represents an increase of 0.0002 in the factor for an increase of 1.0°API. Therefore, by simple proportion, an increase in gravity from 64.0 to 64.80°API increases the factor by 0.8 × 0.0002 or	**0.0002**
Hence, one U.S. gallon of oil having a gravity of 64.80°API at 60°F and measured at 34°F occupies at 60°F a volume of 1.0168 + 0.0002 or	**1.0170 U.S. gallons**
Then, 63,162 U.S. gallons measured at 34°F occupy at 60°F a volume of 63,162 × 1.0170 or	**64,236 U.S. gallons**

Table 6

Volume Reduction to 60° F.

30-39° API

0-50° F.

Observed Temperature, °F.	API Gravity at 60° F.									
	30	31	32	33	34	35	36	37	38	39
	Factor for Reducing Volume to 60° F.									
0	1.0256	1.0258	1.0261	1.0263	1.0266	1.0268	1.0271	1.0274	1.0277	1.0280
1	1.0252	1.0254	1.0257	1.0259	1.0261	1.0264	1.0267	1.0270	1.0273	1.0276
2	1.0247	1.0250	1.0252	1.0255	1.0257	1.0259	1.0262	1.0265	1.0268	1.0271
3	1.0243	1.0246	1.0248	1.0250	1.0253	1.0255	1.0258	1.0261	1.0263	1.0266
4	1.0239	1.0241	1.0243	1.0246	1.0248	1.0250	1.0253	1.0256	1.0259	1.0261
5	1.0235	1.0237	1.0239	1.0241	1.0244	1.0246	1.0249	1.0251	1.0254	1.0257
6	1.0230	1.0233	1.0235	1.0237	1.0239	1.0242	1.0244	1.0247	1.0249	1.0252
7	1.0226	1.0228	1.0230	1.0233	1.0235	1.0237	1.0240	1.0242	1.0245	1.0247
8	1.0222	1.0224	1.0226	1.0228	1.0230	1.0233	1.0235	1.0238	1.0240	1.0243
9	1.0217	1.0220	1.0222	1.0224	1.0226	1.0228	1.0231	1.0233	1.0236	1.0238
10	1.0213	1.0215	1.0217	1.0219	1.0221	1.0224	1.0226	1.0229	1.0231	1.0233
11	1.0209	1.0211	1.0213	1.0215	1.0217	1.0219	1.0222	1.0224	1.0226	1.0229
12	1.0205	1.0207	1.0209	1.0211	1.0213	1.0215	1.0217	1.0219	1.0222	1.0224
13	1.0200	1.0202	1.0204	1.0206	1.0208	1.0210	1.0212	1.0215	1.0217	1.0219
14	1.0196	1.0198	1.0200	1.0202	1.0204	1.0206	1.0208	1.0210	1.0212	1.0215
15	1.0192	1.0194	1.0196	1.0197	1.0199	1.0201	1.0203	1.0206	1.0208	1.0210
16	1.0187	1.0189	1.0191	1.0193	1.0195	1.0197	1.0199	1.0201	1.0203	1.0205
17	1.0183	1.0185	1.0187	1.0189	1.0190	1.0192	1.0194	1.0196	1.0199	1.0201
18	1.0179	1.0181	1.0182	1.0184	1.0186	1.0188	1.0190	1.0192	1.0194	1.0196
19	1.0175	1.0176	1.0178	1.0180	1.0182	1.0183	1.0185	1.0187	1.0189	1.0191
20	1.0170	1.0172	1.0174	1.0175	1.0177	1.0179	1.0181	1.0183	1.0185	1.0187
21	1.0166	1.0168	1.0169	1.0171	1.0173	1.0174	1.0176	1.0178	1.0180	1.0182
22	1.0162	1.0163	1.0165	1.0167	1.0168	1.0170	1.0172	1:0174	1.0175	1.0177
23	1.0158	1.0159	1.0161	1.0162	1.0164	1.0165	1.0167	1.0169	1.0171	1.0173
24	1.0153	1.0155	1.0156	1.0158	1.0159	1.0161	1.0163	1.0164	1.0166	1.0168
25	1.0149	1.0150	1.0152	1.0153	1.0155	1.0156	1.0158	1.0160	1.0162	1.0163
26	1.0145	1.0146	1.0148	1.0149	1.0150	1.0152	1.0154	1.0155	1.0157	1.0159
27	1.0140	1.0142	1.0143	1.0145	1.0146	1.0147	1.0149	1.0151	1.0152	1.0154
28	1.0136	1.0138	1.0139	1.0140	1.0142	1.0143	1.0145	1.0146	1.0148	1.0149
29	1.0132	1.0133	1.0135	1.0136	1.0137	1.0138	1.0140	1.0142	1.0143	1.0145
30	1.0128	1.0129	1.0130	1.0131	1.0133	1.0134	1.0136	1.0137	1.0139	1.0140
31	1.0123	1.0125	1.0126	1.0127	1.0128	1.0130	1.0131	1.0132	1.0134	1.0135
32	1.0119	1.0120	1.0121	1.0123	1.0124	1.0125	1.0126	1.0128	1.0129	1.0131
33	1.0115	1.0116	1.0117	1.0118	1.0119	1.0121	1.0122	1.0123	1.0125	1.0126
34	1.0111	1.0112	1.0113	1.0114	1.0115	1.0116	1.0117	1.0119	1.0120	1.0121
35	1.0106	1.0107	1.0108	1.0110	1.0111	1.0112	1.0113	1.0114	1.0115	1.0117
36	1.0102	1.0103	1.0104	1.0105	1.0106	1.0107	1.0108	1.0110	1.0111	1.0112
37	1.0098	1.0099	1.0100	1.0101	1.0102	1.0103	1.0104	1.0105	1.0106	1.0107
38	1.0094	1.0094	1.0095	1.0096	1.0097	1.0098	1.0099	1.0100	1.0102	1.0103
39	1.0089	1.0090	1.0091	1.0092	1.0093	1.0094	1.0095	1.0096	1.0097	1.0098
40	1.0085	1.0086	1.0087	1.0088	1.0088	1.0089	1.0090	1.0091	1.0092	1.0093
41	1.0081	1.0082	1.0082	1.0083	1.0084	1.0085	1.0086	1.0087	1.0088	1.0089
42	1.0077	1.0077	1.0078	1.0079	1.0080	1.0080	1.0081	1.0082	1.0083	1.0084
43	1.0072	1.0073	1.0074	1.0074	1.0075	1.0076	1.0077	1.0078	1.0078	1.0079
44	1.0068	1.0069	1.0069	1.0070	1.0071	1.0071	1.0072	1.0073	1.0074	1.0075
45	1.0064	1.0064	1.0065	1.0066	1.0066	1.0067	1.0068	1.0068	1.0069	1.0070
46	1.0059	1.0060	1.0061	1.0061	1.0062	1.0062	1.0063	1.0064	1.0065	1.0065
47	1.0055	1.0056	1.0056	1.0057	1.0057	1.0058	1.0059	1.0059	1.0060	1.0061
48	1.0051	1.0051	1.0052	1.0053	1.0053	1.0054	1.0054	1.0055	1.0055	1.0056
49	1.0047	1.0047	1.0048	1.0048	1.0049	1.0049	1.0050	1.0050	1.0051	1.0051
50	1.0042	1.0043	1.0043	1.0044	1.0044	1.0045	1.0045	1.0046	1.0046	1.0047

591

Table 6

30-39° API **Volume Reduction to 60° F.**

50-100° F.

Observed Temperature, °F.	API Gravity at 60° F.									
	30	31	32	33	34	35	36	37	38	39
	Factor for Reducing Volume to 60° F.									
50	1.0042	1.0043	1.0043	1.0044	1.0044	1.0045	1.0045	1.0046	1.0046	1.0047
51	1.0038	1.0039	1.0039	1.0039	1.0040	1.0040	1.0041	1.0041	1.0042	1.0042
52	1.0034	1.0034	1.0035	1.0035	1.0035	1.0036	1.0036	1.0037	1.0037	1.0037
53	1.0030	1.0030	1.0030	1.0031	1.0031	1.0031	1.0032	1.0032	1.0032	1.0033
54	1.0025	1.0026	1.0026	1.0026	1.0027	1.0027	1.0027	1.0027	1.0028	1.0028
55	1.0021	1.0021	1.0022	1.0022	1.0022	1.0022	1.0023	1.0023	1.0023	1.0023
56	1.0017	1.0017	1.0017	1.0017	1.0018	1.0018	1.0018	1.0018	1.0018	1.0019
57	1.0013	1.0013	1.0012	1.0013	1.0013	1.0013	1.0014	1.0014	1.0014	1.0014
58	1.0008	1.0009	1.0009	1.0009	1.0009	1.0009	1.0009	1.0009	1.0009	1.0009
59	1.0004	1.0004	1.0004	1.0004	1.0004	1.0004	1.0005	1.0005	1.0005	1.0005
60	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
61	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9995	0.9995	0.9995	0.9996
62	0.9992	0.9991	0.9991	0.9991	0.9991	0.9991	0.9991	0.9991	0.9991	0.9991
63	0.9987	0.9987	0.9987	0.9987	0.9987	0.9987	0.9986	0.9986	0.9986	0.9986
64	0.9983	0.9983	0.9983	0.9983	0.9982	0.9982	0.9982	0.9982	0.9982	0.9981
65	0.9979	0.9979	0.9978	0.9978	0.9978	0.9978	0.9977	0.9977	0.9977	0.9977
66	0.9975	0.9974	0.9974	0.9974	0.9974	0.9973	0.9973	0.9973	0.9972	0.9972
67	0.9970	0.9970	0.9970	0.9969	0.9969	0.9969	0.9968	0.9968	0.9968	0.9967
68	0.9966	0.9966	0.9965	0.9965	0.9965	0.9964	0.9964	0.9964	0.9963	0.9963
69	0.9962	0.9961	0.9961	0.9961	0.9960	0.9960	0.9959	0.9959	0.9958	0.9958
70	0.9958	0.9957	0.9957	0.9956	0.9956	0.9955	0.9955	0.9954	0.9954	0.9953
71	0.9953	0.9953	0.9952	0.9952	0.9951	0.9951	0.9950	0.9950	0.9949	0.9949
72	0.9949	0.9949	0.9948	0.9948	0.9947	0.9947	0.9946	0.9945	0.9945	0.9944
73	0.9945	0.9944	0.9944	0.9943	0.9943	0.9942	0.9941	0.9941	0.9940	0.9939
74	0.9941	0.9940	0.9939	0.9939	0.9938	0.9938	0.9937	0.9936	0.9935	0.9935
75	0.9936	0.9936	0.9935	0.9934	0.9934	0.9933	0.9932	0.9932	0.9931	0.9930
76	0.9932	0.9932	0.9931	0.9930	0.9929	0.9929	0.9928	0.9927	0.9926	0.9925
77	0.9928	0.9927	0.9927	0.9926	0.9925	0.9924	0.9923	0.9922	0.9922	0.9921
78	0.9924	0.9923	0.9922	0.9921	0.9921	0.9920	0.9919	0.9918	0.9917	0.9916
79	0.9920	0.9919	0.9918	0.9917	0.9916	0.9915	0.9914	0.9913	0.9912	0.9911
80	0.9915	0.9914	0.9914	0.9913	0.9912	0.9911	0.9910	0.9909	0.9908	0.9907
81	0.9911	0.9910	0.9909	0.9908	0.9907	0.9906	0.9905	0.9904	0.9903	0.9902
82	0.9907	0.9906	0.9905	0.9904	0.9903	0.9902	0.9901	0.9900	0.9899	0.9897
83	0.9903	0.9902	0.9901	0.9900	0.9899	0.9898	0.9896	0.9895	0.9894	0.9893
84	0.9898	0.9897	0.9896	0.9895	0.9894	0.9893	0.9892	0.9891	0.9890	0.9888
85	0.9894	0.9893	0.9892	0.9891	0.9890	0.9889	0.9887	0.9886	0.9885	0.9883
86	0.9890	0.9889	0.9888	0.9887	0.9885	0.9884	0.9883	0.9881	0.9880	0.9879
87	0.9886	0.9885	0.9883	0.9882	0.9881	0.9880	0.9878	0.9877	0.9876	0.9874
88	0.9882	0.9880	0.9879	0.9878	0.9877	0.9875	0.9874	0.9872	0.9871	0.9869
89	0.9877	0.9876	0.9875	0.9873	0.9872	0.9871	0.9869	0.9868	0.9866	0.9865
90	0.9873	0.9872	0.9870	0.9869	0.9868	0.9866	0.9865	0.9863	0.9862	0.9860
91	0.9869	0.9867	0.9866	0.9865	0.9863	0.9862	0.9860	0.9859	0.9857	0.9856
92	0.9865	0.9863	0.9862	0.9860	0.9859	0.9858	0.9856	0.9854	0.9853	0.9851
93	0.9860	0.9859	0.9858	0.9856	0.9855	0.9853	0.9851	0.9850	0.9848	0.9846
94	0.9856	0.9855	0.9853	0.9852	0.9850	0.9849	0.9847	0.9845	0.9843	0.9842
95	0.9852	0.9850	0.9849	0.9847	0.9846	0.9844	0.9842	0.9841	0.9839	0.9837
96	0.9848	0.9846	0.9845	0.9843	0.9841	0.9840	0.9838	0.9836	0.9834	0.9832
97	0.9844	0.9842	0.9840	0.9839	0.9837	0.9835	0.9833	0.9831	0.9829	0.9828
98	0.9839	0.9838	0.9836	0.9834	0.9833	0.9831	0.9829	0.9827	0.9825	0.9823
99	0.9835	0.9833	0.9832	0.9830	0.9828	0.9826	0.9824	0.9822	0.9820	0.9818
100	0.9831	0.9829	0.9827	0.9826	0.9824	0.9822	0.9820	0.9818	0.9816	0.9814

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Table 6

Volume Reduction to 60° F.

30-39° API

100-150° F.

Observed Temperature, °F.	API Gravity at 60° F.									
	30	31	32	33	34	35	36	37	38	39
	Factor for Reducing Volume to 60° F.									
100	0.9831	0.9829	0.9827	0.9826	0.9824	0.9822	0.9820	0.9818	0.9816	0.9814
101	0.9827	0.9825	0.9823	0.9821	0.9819	0.9818	0.9815	0.9813	0.9811	0.9809
102	0.9823	0.9821	0.9819	0.9817	0.9815	0.9813	0.9811	0.9809	0.9806	0.9804
103	0.9818	0.9816	0.9814	0.9813	0.9811	0.9809	0.9806	0.9804	0.9802	0.9800
104	0.9814	0.9812	0.9810	0.9808	0.9806	0.9804	0.9802	0.9800	0.9797	0.9795
105	0.9810	0.9808	0.9806	0.9804	0.9802	0.9800	0.9797	0.9795	0.9793	0.9790
106	0.9806	0.9804	0.9802	0.9799	0.9797	0.9795	0.9793	0.9790	0.9788	0.9786
107	0.9801	0.9799	0.9797	0.9795	0.9793	0.9791	0.9788	0.9786	0.9783	0.9781
108	0.9797	0.9795	0.9793	0.9791	0.9789	0.9786	0.9784	0.9781	0.9779	0.9776
109	0.9793	0.9791	0.9789	0.9786	0.9784	0.9782	0.9779	0.9777	0.9774	0.9772
110	0.9789	0.9787	0.9784	0.9782	0.9780	0.9778	0.9775	0.9772	0.9770	0.9767
111	0.9785	0.9782	0.9780	0.9778	0.9775	0.9773	0.9770	0.9768	0.9765	0.976[illegible]
112	0.9780	0.9778	0.9776	0.9773	0.9771	0.9769	0.9766	0.9763	0.9760	[illegible]
113	0.9776	0.9774	0.9772	0.9769	0.9767	0.9764	0.9761	0.9759	0.9756	0.975[illegible]
114	0.9772	0.9770	0.9767	0.9765	0.9762	0.9760	0.9757	0.9754	0.9751	0.9748
115	0.9768	0.9765	0.9763	0.9760	0.9758	0.9755	0.9753	0.9750	0.9747	0.9744
116	0.9764	0.9761	0.9759	0.9756	0.9754	0.9751	0.9748	0.9745	0.9742	0.9739
117	0.9759	0.9757	0.9754	0.9752	0.9749	0.9747	0.9744	0.9740	0.9737	0.9734
118	0.9755	0.9753	0.9750	0.9747	0.9745	0.9742	0.9739	0.9736	0.9733	0.9730
119	0.9751	0.9748	0.9746	0.9743	0.9740	0.9738	0.9735	0.9731	0.9728	0.9725
120	0.9747	0.9744	0.9741	0.9739	0.9736	0.9733	0.9730	0.9727	0.9724	0.9721
121	0.9743	0.9740	0.9737	0.9734	0.9732	0.9729	0.9726	0.9722	0.9719	0.9716
122	0.9739	0.9736	0.9733	0.9730	0.9727	0.9724	0.9721	0.9718	0.9714	0.9711
123	0.9734	0.9731	0.9729	0.9726	0.9723	0.9720	0.9717	0.9713	0.9710	0.9707
124	0.9730	0.9727	0.9724	0.9721	0.9718	0.9716	0.9712	0.9709	0.9705	0.9702
125	0.9726	0.9723	0.9720	0.9717	0.9714	0.9711	0.9708	0.9704	0.9701	0.9697
126	0.9722	0.9719	0.9716	0.9713	0.9710	0.9707	0.9703	0.9700	0.9696	0.9693
127	0.9718	0.9714	0.9711	0.9708	0.9705	0.9702	0.9699	0.9695	0.9692	0.9688
128	0.9713	0.9710	0.9707	0.9704	0.9701	0.9698	0.9694	0.9691	0.9687	0.9683
129	0.9709	0.9706	0.9703	0.9700	0.9697	0.9693	0.9690	0.9686	0.9682	0.9679
130	0.9705	0.9702	0.9699	0.9695	0.9692	0.9689	0.9685	0.9681	0.9678	0.9674
131	0.9701	0.9698	0.9694	0.9691	0.9688	0.9684	0.9681	0.9677	0.9673	0.9669
132	0.9697	0.9693	0.9690	0.9687	0.9683	0.9680	0.9676	0.9672	0.9669	0.9665
133	0.9692	0.9689	0.9686	0.9682	0.9679	0.9676	0.9672	0.9668	0.9664	0.9660
134	0.9688	0.9685	0.9682	0.9678	0.9675	0.9671	0.9667	0.9663	0.9659	0.9655
135	0.9684	0.9681	0.9677	0.9674	0.9670	0.9667	0.9663	0.9659	0.9655	0.9651
136	0.9680	0.9676	0.9673	0.9669	0.9666	0.9662	0.9658	0.9654	0.9650	0.9646
137	0.9676	0.9672	0.9669	0.9665	0.9662	0.9658	0.9654	0.9650	0.9646	0.9641
138	0.9672	0.9668	0.9664	0.9661	0.9657	0.9654	0.9649	0.9645	0.9641	0.9637
139	0.9667	0.9664	0.9660	0.9656	0.9653	0.9649	0.9645	0.9641	0.9636	0.9632
140	0.9663	0.9659	0.9656	0.9652	0.9648	0.9645	0.9640	0.9636	0.9632	0.9628
141	0.9659	0.9655	0.9652	0.9648	0.9644	0.9640	0.9636	0.9632	0.9627	0.9623
142	0.9655	0.9651	0.9647	0.9643	0.9640	0.9636	0.9631	0.9627	0.9623	0.9618
143	0.9651	0.9647	0.9643	0.9639	0.9635	0.9631	0.9627	0.9622	0.9618	0.9614
144	0.9646	0.9643	0.9639	0.9635	0.9631	0.9627	0.9622	0.9618	0.9613	0.9609
145	0.9642	0.9638	0.9634	0.9630	0.9627	0.9623	0.9618	0.9613	0.9609	0.9604
146	0.9638	0.9634	0.9630	0.9626	0.9622	0.9618	0.9614	0.9609	0.9604	0.9600
147	0.9634	0.9630	0.9626	0.9622	0.9618	0.9614	0.9609	0.9604	0.9600	0.9595
148	0.9630	0.9626	0.9622	0.9617	0.9613	0.9609	0.9605	0.9600	0.9595	0.9590
149	0.9626	0.9621	0.9617	0.9613	0.9609	0.9605	0.9600	0.9595	0.9590	0.9586
150	0.9621	0.9617	0.9613	0.9609	0.9605	0.9600	0.9596	0.9591	0.9586	0.9581

601

593

Table 6

30-39° API

Volume Reduction to 60° F.

150-200° F.

Observed Temperature, °F.	API Gravity at 60° F.									
	30	31	32	33	34	35	36	37	38	39
	Factor for Reducing Volume to 60° F.									
150	0.9621	0.9617	0.9613	0.9609	0.9605	0.9600	0.9596	0.9591	0.9586	0.9581
151	0.9617	0.9613	0.9609	0.9605	0.9600	0.9596	0.9591	0.9586	0.9581	0.9576
152	0.9613	0.9609	0.9605	0.9600	0.9596	0.9592	0.9587	0.9582	0.9577	0.9572
153	0.9609	0.9605	0.9600	0.9596	0.9592	0.9587	0.9582	0.9577	0.9572	0.9567
154	0.9605	0.9600	0.9596	0.9592	0.9587	0.9583	0.9578	0.9573	0.9568	0.9562
155	0.9601	0.9596	0.9592	0.9587	0.9583	0.9578	0.9573	0.9568	0.9563	0.9558
156	0.9596	0.9592	0.9588	0.9583	0.9579	0.9574	0.9569	0.9564	0.9558	0.9553
157	0.9592	0.9588	0.9583	0.9579	0.9574	0.9570	0.9564	0.9559	0.9554	0.9549
158	0.9588	0.9584	0.9579	0.9574	0.9570	0.9565	0.9560	0.9554	0.9549	0.9544
159	0.9584	0.9579	0.9575	0.9570	0.9565	0.9561	0.9555	0.9550	0.9545	0.9539
160	0.9580	0.9575	0.9571	0.9566	0.9561	0.9556	0.9551	0.9546	0.9540	0.9535
161	0.9576	0.9571	0.9566	0.9561	0.9557	0.9552	0.9546	0.9541	0.9535	0.9530
162	0.9571	0.9567	0.9562	0.9557	0.9552	0.9547	0.9542	0.9536	0.9531	0.9525
163	0.9567	0.9562	0.9558	0.9553	0.9548	0.9543	0.9537	0.9532	0.9526	0.9521
164	0.9563	0.9558	0.9553	0.9548	0.9544	0.9539	0.9533	0.9527	0.9522	0.9516
165	0.9559	0.9554	0.9549	0.9544	0.9539	0.9534	0.9529	0.9523	0.9517	0.9511
166	0.9555	0.9550	0.9545	0.9540	0.9535	0.9530	0.9524	0.9518	0.9512	0.9507
167	0.9551	0.9546	0.9541	0.9536	0.9531	0.9525	0.9520	0.9514	0.9508	0.9502
168	0.9547	0.9541	0.9536	0.9531	0.9526	0.9521	0.9515	0.9509	0.9503	0.9497
169	0.9542	0.9537	0.9532	0.9527	0.9522	0.9517	0.9511	0.9505	0.9499	0.9493
170	0.9538	0.9533	0.9528	0.9523	0.9518	0.9512	0.9506	0.9500	0.9494	0.9488
171	0.9534	0.9529	0.9524	0.9518	0.9513	0.9508	0.9502	0.9496	0.9490	0.9484
172	0.9530	0.9525	0.9519	0.9514	0.9509	0.9503	0.9497	0.9491	0.9485	0.9479
173	0.9526	0.9520	0.9515	0.9510	0.9504	0.9499	0.9493	0.9487	0.9480	0.9474
174	0.9522	0.9516	0.9511	0.9505	0.9500	0.9495	0.9488	0.9482	0.9476	0.9470
175	0.9517	0.9512	0.9507	0.9501	0.9496	0.9490	0.9484	0.9477	0.9471	0.9465
176	0.9513	0.9508	0.9502	0.9497	0.9491	0.9486	0.9479	0.9473	0.9467	0.9460
177	0.9509	0.9504	0.9498	0.9492	0.9487	0.9481	0.9475	0.9468	0.9462	0.9456
178	0.9505	0.9499	0.9494	0.9488	0.9483	0.9477	0.9470	0.9464	0.9457	0.9451
179	0.9501	0.9495	0.9490	0.9484	0.9478	0.9473	0.9466	0.9459	0.9453	0.9446
180	0.9497	0.9491	0.9485	0.9480	0.9474	0.9468	0.9462	0.9455	0.9448	0.9442
181	0.9493	0.9487	0.9481	0.9475	0.9470	0.9464	0.9457	0.9450	0.9444	0.9437
182	0.9488	0.9483	0.9477	0.9471	0.9465	0.9459	0.9453	0.9446	0.9439	0.9432
183	0.9484	0.9478	0.9473	0.9467	0.9461	0.9455	0.9448	0.9441	0.9435	0.9428
184	0.9480	0.9474	0.9468	0.9462	0.9457	0.9450	0.9444	0.9437	0.9430	0.9423
185	0.9476	0.9470	0.9464	0.9458	0.9452	0.9446	0.9439	0.9432	0.9425	0.9419
186	0.9472	0.9466	0.9460	0.9454	0.9448	0.9442	0.9435	0.9428	0.9421	0.9414
187	0.9468	0.9462	0.9456	0.9449	0.9444	0.9437	0.9430	0.9423	0.9416	0.9409
188	0.9464	0.9457	0.9451	0.9445	0.9439	0.9433	0.9426	0.9419	0.9412	0.9405
189	0.9459	0.9453	0.9447	0.9441	0.9435	0.9428	0.9421	0.9414	0.9407	0.9400
190	0.9455	0.9449	0.9443	0.9437	0.9430	0.9424	0.9417	0.9410	0.9403	0.9395
191	0.9451	0.9445	0.9439	0.9432	0.9426	0.9420	0.9412	0.9405	0.9398	0.9391
192	0.9447	0.9441	0.9434	0.9428	0.9422	0.9415	0.9408	0.9401	0.9393	0.9386
193	0.9443	0.9437	0.9430	0.9424	0.9417	0.9411	0.9404	0.9396	0.9389	0.9381
194	0.9439	0.9432	0.9426	0.9419	0.9413	0.9406	0.9399	0.9392	0.9384	0.9377
195	0.9431	0.9428	0.9422	0.9415	0.9409	0.9402	0.9395	0.9387	0.9380	0.9372
196	0.9435	0.9424	0.9418	0.9411	0.9404	0.9398	0.9390	0.9383	0.9375	0.9368
197	0.9426	0.9420	0.9413	0.9407	0.9400	0.9393	0.9386	0.9378	0.9370	0.9363
198	0.9422	0.9416	0.9409	0.9402	0.9396	0.9389	0.9381	0.9373	0.9366	0.9358
199	0.9418	0.9411	0.9405	0.9398	0.9391	0.9385	0.9377	0.9369	0.9361	0.9354
200	0.9414	0.9407	0.9401	0.9394	0.9387	0.9380	0.9372	0.9364	0.9357	0.9349

602

Table 6

Volume Reduction to 60° F.

40–49° API

0-50° F.

Observed Temperature, °F.	API Gravity at 60° F.									
	40	41	42	43	44	45	46	47	48	49
	Factor for Reducing Volume to 60° F.									
0	1.0284	1.0287	1.0291	1.0294	1.0298	1.0302	1.0306	1.0310	1.0314	1.0319
1	1.0279	1.0282	1.0286	1.0289	1.0293	1.0297	1.0301	1.0305	1.0309	1.0313
2	1.0274	1.0278	1.0281	1.0284	1.0288	1.0292	1.0296	1.0299	1.0304	1.0308
3	1.0269	1.0273	1.0276	1.0279	1.0283	1.0287	1.0290	1.0294	1.0299	1.0303
4	1.0265	1.0268	1.0271	1.0274	1.0278	1.0282	1.0285	1.0289	1.0293	1.0298
5	1.0260	1.0263	1.0266	1.0269	1.0273	1.0277	1.0280	1.0284	1.0288	1.0292
6	1.0255	1.0258	1.0261	1.0265	1.0268	1.0272	1.0275	1.0279	1.0283	1.0287
7	1.0250	1.0254	1.0257	1.0260	1.0263	1.0267	1.0270	1.0274	1.0278	1.0282
8	1.0246	1.0249	1.0252	1.0255	1.0258	1.0262	1.0265	1.0269	1.0272	1.0276
9	1.0241	1.0244	1.0247	1.0250	1.0253	1.0257	1.0260	1.0263	1.0267	1.0271
10	1.0236	1.0239	1.0242	1.0245	1.0248	1.0252	1.0255	1.0258	1.0262	1.0266
11	1.0232	1.0234	1.0237	1.0240	1.0243	1.0247	1.0250	1.0253	1.0257	1.0260
12	1.0227	1.0230	1.0232	1.0235	1.0238	1.0242	1.0245	1.0248	1.0252	1.0255
13	1.0222	1.0225	1.0228	1.0230	1.0233	1.0236	1.0240	1.0243	1.0246	1.0250
14	1.0217	1.0220	1.0223	1.0225	1.0228	1.0231	1.0235	1.0238	1.0241	1.0245
15	1.0213	1.0215	1.0218	1.0221	1.0223	1.0226	1.0229	1.0232	1.0236	1.0239
16	1.0208	1.0211	1.0213	1.0216	1.0218	1.0221	1.0224	1.0227	1.0231	1.0234
17	1.0203	1.0206	1.0208	1.0211	1.0214	1.0216	1.0219	1.0222	1.0225	1.0229
18	1.0198	1.0201	1.0203	1.0206	1.0209	1.0211	1.0214	1.0217	1.0220	1.0223
19	1.0194	1.0196	1.0199	1.0201	1.0204	1.0206	1.0209	1.0212	1.0215	1.0218
20	1.0189	1.0191	1.0194	1.0196	1.0199	1.0201	1.0204	1.0207	1.0210	1.0213
21	1.0184	1.0187	1.0189	1.0191	1.0194	1.0196	1.0199	1.0201	1.0204	1.0207
22	1.0180	1.0182	1.0184	1.0186	1.0189	1.0191	1.0194	1.0196	1.0199	1.0202
23	1.0175	1.0177	1.0179	1.0181	1.0184	1.0186	1.0189	1.0191	1.0194	1.0197
24	1.0170	1.0172	1.0174	1.0176	1.0179	1.0181	1.0184	1.0186	1.0189	1.0191
25	1.0165	1.0167	1.0169	1.0172	1.0174	1.0176	1.0178	1.0181	1.0184	1.0186
26	1.0161	1.0163	1.0165	1.0167	1.0169	1.0171	1.0173	1.0176	1.0178	1.0181
27	1.0156	1.0158	1.0160	1.0162	1.0164	1.0166	1.0168	1.0171	1.0173	1.0176
28	1.0151	1.0153	1.0155	1.0157	1.0159	1.0161	1.0163	1.0165	1.0168	1.0170
29	1.0146	1.0148	1.0150	1.0152	1.0154	1.0156	1.0158	1.0160	1.0163	1.0165
30	1.0142	1.0144	1.0145	1.0147	1.0149	1.0151	1.0153	1.0155	1.0157	1.0160
31	1.0137	1.0139	1.0140	1.0142	1.0144	1.0146	1.0148	1.0150	1.0152	1.0154
32	1.0132	1.0134	1.0136	1.0137	1.0139	1.0141	1.0143	1.0145	1.0147	1.0149
33	1.0128	1.0129	1.0131	1.0132	1.0134	1.0136	1.0138	1.0140	1.0142	1.0144
34	1.0123	1.0124	1.0126	1.0127	1.0129	1.0131	1.0133	1.0134	1.0136	1.0138
35	1.0118	1.0120	1.0121	1.0123	1.0124	1.0126	1.0128	1.0129	1.0131	1.0133
36	1.0113	1.0115	1.0116	1.0118	1.0119	1.0121	1.0122	1.0124	1.0126	1.0128
37	1.0109	1.0110	1.0111	1.0113	1.0114	1.0116	1.0117	1.0119	1.0121	1.0122
38	1.0104	1.0105	1.0107	1.0108	1.0109	1.0111	1.0112	1.0114	1.0115	1.0117
39	1.0099	1.0100	1.0102	1.0103	1.0104	1.0106	1.0107	1.0109	1.0110	1.0112
40	1.0094	1.0096	1.0097	1.0098	1.0099	1.0101	1.0102	1.0103	1.0105	1.0106
41	1.0090	1.0091	1.0092	1.0093	1.0094	1.0096	1.0097	1.0098	1.0100	1.0101
42	1.0085	1.0086	1.0087	1.0088	1.0089	1.0091	1.0092	1.0093	1.0094	1.0096
43	1.0080	1.0081	1.0082	1.0083	1.0084	1.0086	1.0087	1.0088	1.0089	1.0091
44	1.0076	1.0077	1.0077	1.0078	1.0079	1.0081	1.0082	1.0083	1.0084	1.0085
45	1.0071	1.0072	1.0073	1.0074	1.0075	1.0076	1.0077	1.0078	1.0079	1.0080
46	1.0066	1.0067	1.0068	1.0069	1.0070	1.0070	1.0071	1.0072	1.0073	1.0075
47	1.0061	1.0062	1.0063	1.0064	1.0065	1.0065	1.0066	1.0067	1.0068	1.0069
48	1.0057	1.0057	1.0058	1.0059	1.0060	1.0060	1.0061	1.0062	1.0063	1.0064
49	1.0052	1.0053	1.0053	1.0054	1.0055	1.0055	1.0056	1.0057	1.0058	1.0059
50	1.0047	1.0048	1.0048	1.0049	1.0050	1.0050	1.0051	1.0052	1.0052	1.0053

Table 6

40–49° API

Volume Reduction to 60° F.

50-100° F.

Observed Temperature, °F.	API Gravity at 60° F.									
	40	41	42	43	44	45	46	47	48	49
	Factor for Reducing Volume to 60° F.									
50	1.0047	1.0048	1.0048	1.0049	1.0050	1.0050	1.0051	1.0052	1.0052	1.0053
51	1.0043	1.0043	1.0044	1.0044	1.0045	1.0045	1.0046	1.0047	1.0047	1.0048
52	1.0038	1.0038	1.0039	1.0039	1.0040	1.0040	1.0041	1.0041	1.0042	1.0043
53	1.0033	1.0033	1.0034	1.0034	1.0035	1.0035	1.0036	1.0036	1.0037	1.0037
54	1.0028	1.0029	1.0029	1.0029	1.0030	1.0030	1.0031	1.0031	1.0031	1.0032
55	1.0024	1.0024	1.0024	1.0025	1.0025	1.0025	1.0026	1.0026	1.0026	1.0027
56	1.0019	1.0019	1.0019	1.0020	1.0020	1.0020	1.0020	1.0021	1.0021	1.0021
57	1.0014	1.0014	1.0015	1.0015	1.0015	1.0015	1.0015	1.0016	1.0016	1.0016
58	1.0009	1.0010	1.0010	1.0010	1.0010	1.0010	1.0010	1.0010	1.0011	1.0011
59	1.0005	1.0005	1.0005	1.0005	1.0005	1.0005	1.0005	1.0005	1.0005	1.0005
60	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
61	0.9995	0.9995	0.9995	0.9995	0.9995	0.9995	0.9995	0.9995	0.9995	0.9995
62	0.9991	0.9990	0.9990	0.9990	0.9990	0.9990	0.9990	0.9990	0.9989	0.9989
63	0.9986	0.9986	0.9985	0.9985	0.9985	0.9985	0.9985	0.9984	0.9984	0.9984
64	0.9981	0.9981	0.9981	0.9980	0.9980	0.9980	0.9980	0.9979	0.9979	0.9979
65	0.9976	0.9976	0.9976	0.9975	0.9975	0.9975	0.9974	0.9974	0.9974	0.9973
66	0.9972	0.9971	0.9971	0.9971	0.9970	0.9970	0.9969	0.9969	0.9968	0.9968
67	0.9967	0.9967	0.9966	0.9966	0.9965	0.9965	0.9964	0.9964	0.9963	0.9963
68	0.9962	0.9962	0.9961	0.9961	0.9960	0.9960	0.9959	0.9959	0.9958	0.9957
69	0.9957	0.9957	0.9956	0.9956	0.9955	0.9955	0.9954	0.9953	0.9953	0.9952
70	0.9953	0.9952	0.9952	0.9951	0.9950	0.9950	0.9949	0.9948	0.9947	0.9947
71	0.9948	0.9947	0.9947	0.9946	0.9945	0.9945	0.9944	0.9943	0.9942	0.9941
72	0.9943	0.9943	0.9942	0.9941	0.9940	0.9940	0.9939	0.9938	0.9937	0.9936
73	0.9939	0.9938	0.9937	0.9936	0.9935	0.9935	0.9934	0.9933	0.9932	0.9931
74	0.9934	0.9933	0.9932	0.9931	0.9930	0.9929	0.9929	0.9928	0.9926	0.9925
75	0.9929	0.9928	0.9927	0.9926	0.9925	0.9924	0.9923	0.9922	0.9921	0.9920
76	0.9924	0.9923	0.9923	0.9922	0.9920	0.9919	0.9918	0.9917	0.9916	0.9915
77	0.9920	0.9919	0.9918	0.9917	0.9916	0.9914	0.9913	0.9912	0.9911	0.9909
78	0.9915	0.9914	0.9913	0.9912	0.9911	0.9909	0.9908	0.9907	0.9905	0.9904
79	0.9910	0.9909	0.9908	0.9907	0.9906	0.9904	0.9903	0.9902	0.9900	0.9899
80	0.9906	0.9904	0.9903	0.9902	0.9901	0.9899	0.9898	0.9896	0.9895	0.9893
81	0.9901	0.9900	0.9898	0.9897	0.9896	0.9894	0.9893	0.9891	0.9890	0.9888
82	0.9896	0.9895	0.9893	0.9892	0.9891	0.9889	0.9888	0.9886	0.9884	0.9883
83	0.9891	0.9890	0.9889	0.9887	0.9886	0.9884	0.9883	0.9881	0.9879	0.9877
84	0.9887	0.9885	0.9884	0.9882	0.9881	0.9879	0.9877	0.9876	0.9874	0.9872
85	0.9882	0.9880	0.9879	0.9877	0.9876	0.9874	0.9872	0.9871	0.9869	0.9867
86	0.9877	0.9876	0.9874	0.9873	0.9871	0.9869	0.9867	0.9865	0.9863	0.9861
87	0.9873	0.9871	0.9869	0.9868	0.9866	0.9864	0.9862	0.9860	0.9858	9.9856
88	0.9868	0.9866	0.9864	0.9863	0.9861	0.9859	0.9857	0.9855	0.9853	0.9851
89	0.9863	0.9861	0.9860	0.9858	0.9856	0.9854	0.9852	0.9850	0.9848	0.9845
90	0.9858	0.9857	0.9855	0.9853	0.9851	0.9849	0.9847	0.9845	0.9842	0.9840
91	0.9854	0.9852	0.9850	0.9848	0.9846	0.9844	0.9842	0.9839	0.9837	0.9835
92	0.9849	0.9847	0.9845	0.9843	0.9841	0.9839	0.9836	0.9834	0.9832	0.9829
93	0.9844	0.9842	0.9840	0.9838	0.9836	0.9834	0.9831	0.9829	0.9826	0.9824
94	0.9839	0.9837	0.9835	0.9833	0.9831	0.9829	0.9826	0.9824	0.9821	0.9819
95	0.9835	0.9833	0.9830	0.9828	0.9826	0.9824	0.9821	0.9819	0.9816	0.9813
96	0.9830	0.9828	0.9826	0.9823	0.9821	0.9819	0.9816	0.9814	0.9811	0.9808
97	0.9825	0.9823	0.9821	0.9819	0.9816	0.9813	0.9811	0.9808	0.9805	0.9803
98	0.9821	0.9818	0.9816	0.9814	0.9811	0.9808	0.9806	0.9803	0.9800	0.9797
99	0.9816	0.9814	0.9811	0.9809	0.9806	0.9803	0.9801	0.9798	0.9795	0.9792
100	0.9811	0.9809	0.9806	0.9804	0.9801	0.9798	0.9796	0.9793	0.9790	0.9786

596

Table 6

Volume Reduction to 60° F.

40-49° API

100-150° F.

Observed Temperature, °F.	API Gravity at 60° F.									
	40	41	42	43	44	45	46	47	48	49
	Factor for Reducing Volume to 60° F.									
100	0.9811	0.9809	0.9806	0.9804	0.9801	0.9798	0.9796	0.9793	0.9790	0.9786
101	0.9806	0.9804	0.9801	0.9799	0.9796	0.9793	0.9790	0.9788	0.9784	0.9781
102	0.9802	0.9799	0.9797	0.9794	0.9791	0.9788	0.9785	0.9782	0.9779	0.9776
103	0.9797	0.9794	0.9792	0.9789	0.9786	0.9783	0.9780	0.9777	0.9774	0.9770
104	0.9792	0.9790	0.9787	0.9784	0.9781	0.9778	0.9775	0.9772	0.9769	0.9765
105	0.9788	0.9785	0.9782	0.9779	0.9776	0.9773	0.9770	0.9767	0.9763	0.9760
106	0.9783	0.9780	0.9777	0.9774	0.9771	0.9768	0.9765	0.9762	0.9758	0.9754
107	0.9778	0.9775	0.9772	0.9770	0.9766	0.9763	0.9760	0.9756	0.9753	0.9749
108	0.9773	0.9770	0.9768	0.9765	0.9761	0.9758	0.9755	0.9751	0.9747	0.9744
109	0.9769	0.9766	0.9763	0.9760	0.9756	0.9753	0.9749	0.9746	0.9742	0.9738
110	0.9764	0.9761	0.9758	0.9755	0.9751	0.9748	0.9744	0.9741	0.9737	0.9733
111	0.9759	0.9756	0.9753	0.9750	0.9746	0.9743	0.9739	0.9736	0.9732	0.9728
112	0.9755	0.9751	0.9748	0.9745	0.9741	0.9738	0.9734	0.9731	0.9726	0.9722
113	0.9750	0.9747	0.9743	0.9740	0.9736	0.9733	0.9729	0.9725	0.9721	0.9717
114	0.9745	0.9742	0.9738	0.9735	0.9731	0.9728	0.9724	0.9720	0.9716	0.9712
115	0.9740	0.9737	0.9734	0.9730	0.9726	0.9723	0.9719	0.9715	0.9711	0.9706
116	0.9736	0.9732	0.9729	0.9725	0.9721	0.9718	0.9714	0.9710	0.9705	0.9701
117	0.9731	0.9727	0.9724	0.9720	0.9717	0.9713	0.9709	0.9705	0.9700	0.9695
118	0.9726	0.9723	0.9719	0.9716	0.9712	0.9707	0.9703	0.9699	0.9695	0.9690
119	0.9722	0.9718	0.9714	0.9711	0.9707	0.9702	0.9698	0.9694	0.9689	0.9685
120	0.9717	0.9713	0.9709	0.9706	0.9702	0.9697	0.9693	0.9689	0.9684	0.9679
121	0.9712	0.9708	0.9705	0.9701	0.9697	0.9692	0.9688	0.9684	0.9679	0.9674
122	0.9707	0.9704	0.9700	0.9696	0.9692	0.9687	0.9683	0.9679	0.9674	0.9669
123	0.9703	0.9699	0.9695	0.9691	0.9687	0.9682	0.9678	0.9673	0.9668	0.9663
124	0.9698	0.9694	0.9690	0.9686	0.9682	0.9677	0.9673	0.9668	0.9663	0.9658
125	0.9693	0.9689	0.9685	0.9681	0.9677	0.9672	0.9668	0.9663	0.9658	0.9653
126	0.9689	0.9684	0.9680	0.9676	0.9672	0.9667	0.9662	0.9658	0.9652	0.9647
127	0.9684	0.9680	0.9675	0.9671	0.9667	0.9662	0.9657	0.9653	0.9647	0.9642
128	0.9679	0.9675	0.9671	0.9666	0.9662	0.9657	0.9652	0.9647	0.9642	0.9637
129	0.9674	0.9670	0.9666	0.9662	0.9657	0.9652	0.9647	0.9642	0.9637	0.9631
130	0.9670	0.9665	0.9661	0.9657	0.9652	0.9647	0.9642	0.9637	0.9631	0.9626
131	0.9665	0.9661	0.9656	0.9652	0.9647	0.9642	0.9637	0.9632	0.9626	0.9620
132	0.9660	0.9656	0.9651	0.9647	0.9642	0.9637	0.9632	0.9627	0.9621	0.9615
133	0.9656	0.9651	0.9646	0.9642	0.9637	0.9632	0.9627	0.9621	0.9616	0.9610
134	0.9651	0.9646	0.9642	0.9637	0.9632	0.9627	0.9621	0.9616	0.9610	0.9604
135	0.9646	0.9641	0.9637	0.9632	0.9627	0.9622	0.9616	0.9611	0.9605	0.9599
136	0.9641	0.9637	0.9632	0.9627	0.9622	0.9617	0.9611	0.9606	0.9600	0.9594
137	0.9637	0.9632	0.9627	0.9622	0.9617	0.9611	0.9606	0.9601	0.9594	0.9588
138	0.9632	0.9627	0.9622	0.9617	0.9612	0.9606	0.9601	0.9595	0.9589	0.9583
139	0.9627	0.9622	0.9617	0.9612	0.9607	0.9601	0.9596	0.9590	0.9584	0.9578
140	0.9623	0.9618	0.9612	0.9608	0.9602	0.9596	0.9591	0.9585	0.9579	0.9572
141	0.9618	0.9613	0.9608	0.9603	0.9597	0.9591	0.9586	0.9580	0.9573	0.9567
142	0.9613	0.9608	0.9603	0.9598	0.9592	0.9586	0.9580	0.9575	0.9568	0.9561
143	0.9608	0.9603	0.9598	0.9593	0.9587	0.9581	0.9575	0.9569	0.9563	0.9556
144	0.9604	0.9598	0.9593	0.9588	0.9582	0.9576	0.9570	0.9564	0.9557	0.9551
145	0.9599	0.9594	0.9588	0.9583	0.9577	0.9571	0.9565	0.9559	0.9552	0.9545
146	0.9594	0.9589	0.9583	0.9578	0.9572	0.9566	0.9560	0.9554	0.9547	0.9540
147	0.9590	0.9584	0.9579	0.9573	0.9567	0.9561	0.9555	0.9549	0.9541	0.9535
148	0.9585	0.9579	0.9574	0.9568	0.9562	0.9556	0.9550	0.9543	0.9536	0.9529
149	0.9580	0.9575	0.9569	0.9563	0.9557	0.9551	0.9544	0.9538	0.9531	0.9524
150	0.9575	0.9570	0.9564	0.9558	0.9552	0.9546	0.9539	0.9533	0.9526	0.9518

605

Table 6

50-59° API

Volume Reduction to 60° F.

0-50° F.

Observed Temperature, °F.	API Gravity at 60° F.									
	50	51	52	53	54	55	56	57	58	59
	Factor for Reducing Volume to 60° F.									
0	1.0323	1.0328	1.0332	1.0337	1.0342	1.0347	1.0352	1.0358	1.0362	1.0366
1	1.0318	1.0322	1.0327	1.0332	1.0337	1.0342	1.0347	1.0352	1.0356	1.0360
2	1.0313	1.0317	1.0321	1.0326	1.0331	1.0336	1.0341	1.0346	1.0350	1.0354
3	1.0307	1.0311	1.0316	1.0320	1.0325	1.0330	1.0335	1.0340	1.0344	1.0347
4	1.0302	1.0306	1.0310	1.0315	1.0320	1.0324	1.0329	1.0334	1.0338	1.0341
5	1.0296	1.0300	1.0305	1.0309	1.0314	1.0319	1.0323	1.0328	1.0332	1.0335
6	1.0291	1.0295	1.0299	1.0304	1.0308	1.0313	1.0317	1.0322	1.0326	1.0329
7	1.0286	1.0290	1.0294	1.0298	1.0302	1.0307	1.0312	1.0316	1.0320	1.0323
8	1.0280	1.0284	1.0288	1.0292	1.0297	1.0301	1.0306	1.0310	1.0314	1.0317
9	1.0275	1.0279	1.0283	1.0287	1.0291	1.0295	1.0300	1.0304	1.0308	1.0311
10	1.0270	1.0273	1.0277	1.0281	1.0286	1.0290	1.0294	1.0298	1.0302	1.0305
11	1.0264	1.0268	1.0272	1.0276	1.0280	1.0284	1.0288	1.0292	1.0296	1.0299
12	1.0259	1.0262	1.0266	1.0270	1.0274	1.0278	1.0282	1.0286	1.0290	1.0293
13	1.0253	1.0257	1.0260	1.0264	1.0268	1.0272	1.0276	1.0280	1.0284	1.0287
14	1.0248	1.0251	1.0255	1.0259	1.0263	1.0267	1.0271	1.0275	1.0278	1.0281
15	1.0243	1.0246	1.0249	1.0253	1.0257	1.0261	1.0265	1.0269	1.0272	1.0275
16	1.0237	1.0241	1.0244	1.0247	1.0251	1.0255	1.0259	1.0263	1.0266	1.0269
17	1.0232	1.0235	1.0238	1.0242	1.0246	1.0249	1.0253	1.0257	1.0260	1.0262
18	1.0226	1.0230	1.0233	1.0236	1.0240	1.0244	1.0247	1.0251	1.0253	1.0256
19	1.0221	1.0224	1.0227	1.0231	1.0234	1.0238	1.0241	1.0245	1.0247	1.0250
20	1.0216	1.0219	1.0222	1.0225	1.0228	1.0232	1.0235	1.0239	1.0241	1.0244
21	1.0210	1.0213	1.0216	1.0219	1.0222	1.0226	1.0230	1.0233	1.0235	1.0238
22	1.0205	1.0208	1.0211	1.0214	1.0217	1.0220	1.0224	1.0227	1.0229	1.0232
23	1.0200	1.0202	1.0205	1.0208	1.0211	1.0215	1.0218	1.0221	1.0223	1.0226
24	1.0194	1.0197	1.0200	1.0203	1.0206	1.0209	1.0212	1.0215	1.0217	1.0220
25	1.0189	1.0191	1.0194	1.0197	1.0200	1.0203	1.0206	1.0209	1.0211	1.0214
26	1.0183	1.0186	1.0189	1.0191	1.0194	1.0197	1.0200	1.0203	1.0206	1.0208
27	1.0178	1.0181	1.0183	1.0186	1.0189	1.0191	1.0194	1.0197	1.0199	1.0202
28	1.0173	1.0175	1.0177	1.0180	1.0183	1.0186	1.0188	1.0191	1.0193	1.0196
29	1.0167	1.0170	1.0172	1.0175	1.0177	1.0180	1.0183	1.0185	1.0187	1.0189
30	1.0162	1.0164	1.0166	1.0169	1.0171	1.0174	1.0177	1.0179	1.0181	1.0183
31	1.0157	1.0159	1.0161	1.0163	1.0166	1.0168	1.0171	1.0173	1.0175	1.0177
32	1.0151	1.0153	1.0155	1.0158	1.0160	1.0163	1.0165	1.0167	1.0169	1.0171
33	1.0146	1.0148	1.0150	1.0152	1.0154	1.0157	1.0159	1.0161	1.0163	1.0165
34	1.0140	1.0142	1.0144	1.0146	1.0149	1.0151	1.0153	1.0155	1.0157	1.0159
35	1.0135	1.0137	1.0139	1.0141	1.0143	1.0145	1.0147	1.0149	1.0151	1.0153
36	1.0130	1.0131	1.0133	1.0135	1.0137	1.0139	1.0141	1.0144	1.0145	1.0147
37	1.0124	1.0126	1.0128	1.0130	1.0132	1.0134	1.0136	1.0138	1.0139	1.0141
38	1.0119	1.0120	1.0122	1.0124	1.0126	1.0128	1.0130	1.0132	1.0133	1.0135
39	1.0113	1.0115	1.0117	1.0118	1.0120	1.0122	1.0124	1.0126	1.0127	1.0128
40	1.0108	1.0109	1.0111	1.0113	1.0114	1.0116	1.0118	1.0120	1.0121	1.0122
41	1.0103	1.0104	1.0105	1.0107	1.0109	1.0110	1.0112	1.0114	1.0115	1.0116
42	1.0097	1.0099	1.0100	1.0101	1.0103	1.0105	1.0106	1.0108	1.0109	1.0110
43	1.0092	1.0093	1.0094	1.0096	1.0097	1.0099	1.0100	1.0102	1.0103	1.0104
44	1.0086	1.0088	1.0089	1.0090	1.0092	1.0093	1.0094	1.0096	1.0097	1.0098
45	1.0081	1.0082	1.0083	1.0085	1.0086	1.0087	1.0088	1.0090	1.0091	1.0092
46	1.0076	1.0077	1.0078	1.0079	1.0080	1.0081	1.0083	1.0084	1.0085	1.0086
47	1.0070	1.0071	1.0072	1.0073	1.0074	1.0076	1.0077	1.0078	1.0079	1.0080
48	1.0065	1.0066	1.0067	1.0068	1.0069	1.0070	1.0071	1.0072	1.0073	1.0073
49	1.0059	1.0060	1.0061	1.0062	1.0063	1.0064	1.0065	1.0066	1.0067	1.0067
50	1.0054	1.0055	1.0056	1.0056	1.0057	1.0058	1.0059	1.0060	1.0061	1.0061

598

Table 6

Volume Reduction to 60° F.

50–59° API

50–100° F.

Observed Temperature, °F.	API Gravity at 60° F.									
	50	51	52	53	54	55	56	57	58	59
	Factor for Reducing Volume to 60° F.									
50	1.0054	1.0055	1.0056	1.0056	1.0057	1.0058	1.0059	1.0060	1.0061	1.0061
51	1.0049	1.0049	1.0050	1.0051	1.0052	1.0052	1.0053	1.0054	1.0054	1.0055
52	1.0043	1.0044	1.0044	1.0045	1.0046	1.0047	1.0047	1.0048	1.0048	1.0049
53	1.0038	1.0038	1.0039	1.0039	1.0040	1.0041	1.0041	1.0042	1.0042	1.0043
54	1.0032	1.0033	1.0033	1.0034	1.0034	1.0035	1.0035	1.0036	1.0036	1.0037
55	1.0027	1.0027	1.0028	1.0028	1.0029	1.0029	1.0030	1.0030	1.0030	1.0031
56	1.0022	1.0022	1.0022	1.0023	1.0023	1.0023	1.0024	1.0024	1.0024	1.0025
57	1.0016	1.0016	1.0017	1.0017	1.0017	1.0017	1.0018	1.0018	1.0018	1.0018
58	1.0011	1.0011	1.0011	1.0011	1.0011	1.0012	1.0012	1.0012	1.0012	1.0012
59	1.0005	1.0005	1.0006	1.0006	1.0006	1.0006	1.0006	1.0006	1.0006	1.0006
60	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
61	0.9995	0.9995	0.9994	0.9994	0.9994	0.9994	0.9994	0.9994	0.9994	0.9994
62	0.9989	0.9989	0.9989	0.9989	0.9989	0.9988	0.9988	0.9988	0.9988	0.9988
63	0.9984	0.9984	0.9983	0.9983	0.9983	0.9983	0.9982	0.9982	0.9982	0.9982
64	0.9978	0.9978	0.9978	0.9977	0.9977	0.9977	0.9976	0.9976	0.9976	0.9975
65	0.9973	0.9973	0.9972	0.9972	0.9971	0.9971	0.9970	0.9970	0.9970	0.9969
66	0.9968	0.9967	0.9967	0.9966	0.9966	0.9965	0.9965	0.9964	0.9964	0.9963
67	0.9962	0.9962	0.9961	0.9960	0.9960	0.9959	0.9959	0.9958	0.9958	0.9957
68	0.9957	0.9956	0.9956	0.9955	0.9954	0.9953	0.9953	0.9952	0.9951	0.9951
69	0.9951	0.9951	0.9950	0.9949	0.9948	0.9948	0.9947	0.9946	0.9945	0.9945
70	0.9946	0.9945	0.9944	0.9944	0.9943	0.9942	0.9941	0.9940	0.9939	0.9939
71	0.9941	0.9940	0.9939	0.9938	0.9937	0.9936	0.9935	0.9934	0.9933	0.9932
72	0.9935	0.9934	0.9933	0.9932	0.9931	0.9930	0.9929	0.9928	0.9927	0.9926
73	0.9930	0.9929	0.9928	0.9927	0.9925	0.9924	0.9923	0.9922	0.9921	0.9920
74	0.9924	0.9923	0.9922	0.9921	0.9920	0.9918	0.9917	0.9916	0.9915	0.9914
75	0.9919	0.9918	0.9917	0.9915	0.9914	0.9913	0.9911	0.9910	0.9909	0.9908
76	0.9913	0.9912	0.9911	0.9910	0.9908	0.9907	0.9905	0.9904	0.9903	0.9902
77	0.9908	0.9907	0.9905	0.9904	0.9902	0.9901	0.9899	0.9898	0.9897	0.9896
78	0.9903	0.9901	0.9900	0.9898	0.9897	0.9895	0.9894	0.9892	0.9891	0.9889
79	0.9897	0.9896	0.9894	0.9893	0.9891	0.9889	0.9888	0.9886	0.9885	0.9883
80	0.9892	0.9890	0.9889	0.9887	0.9885	0.9883	0.9882	0.9880	0.9879	0.9877
81	0.9886	0.9885	0.9883	0.9881	0.9880	0.9878	0.9876	0.9874	0.9873	0.9871
82	0.9881	0.9879	0.9878	0.9876	0.9874	0.9872	0.9870	0.9868	0.9866	0.9865
83	0.9876	0.9874	0.9872	0.9870	0.9868	0.9866	0.9864	0.9862	0.9860	0.9859
84	0.9870	0.9868	0.9866	0.9864	0.9862	0.9860	0.9858	0.9856	0.9854	0.9853
85	0.9865	0.9863	0.9861	0.9859	0.9857	0.9854	0.9852	0.9850	0.9848	0.9846
86	0.9859	0.9857	0.9855	0.9853	0.9851	0.9848	0.9846	0.9844	0.9842	0.9840
87	0.9854	0.9852	0.9850	0.9847	0.9845	0.9843	0.9840	0.9838	0.9836	0.9834
88	0.9848	0.9846	0.9844	0.9842	0.9839	0.9837	0.9834	0.9832	0.9830	0.9828
89	0.9843	0.9841	0.9839	0.9836	0.9834	0.9831	0.9828	0.9826	0.9824	0.9822
90	0.9838	0.9835	0.9833	0.9830	0.9828	0.9825	0.9822	0.9820	0.9818	0.9816
91	0.9832	0.9830	0.9827	0.9825	0.9822	0.9819	0.9817	0.9814	0.9812	0.9809
92	0.9827	0.9824	0.9822	0.9819	0.9816	0.9813	0.9811	0.9808	0.9806	0.9803
93	0.9821	0.9819	0.9816	0.9813	0.9810	0.9808	0.9805	0.9802	0.9799	0.9797
94	0.9816	0.9813	0.9811	0.9808	0.9805	0.9802	0.9799	0.9796	0.9793	0.9791
95	0.9810	0.9808	0.9805	0.9802	0.9799	0.9796	0.9793	0.9790	0.9787	0.9785
96	0.9805	0.9802	0.9799	0.9796	0.9793	0.9790	0.9787	0.9784	0.9781	0.9779
97	0.9800	0.9797	0.9794	0.9791	0.9787	0.9784	0.9781	0.9778	0.9775	0.9772
98	0.9794	0.9791	0.9788	0.9785	0.9782	0.9778	0.9775	0.9772	0.9769	0.9766
99	0.9789	0.9786	0.9783	0.9779	0.9776	0.9772	0.9769	0.9766	0.9763	0.9760
100	0.9783	0.9780	0.9777	0.9774	0.9770	0.9767	0.9763	0.9759	0.9757	0.9754

607

599

Table 6

50-59° API Volume Reduction to 60° F.

100-150° F.

Observed Temperature, °F.	API Gravity at 60° F.									
	50	51	52	53	54	55	56	57	58	59
	Factor for Reducing Volume to 60° F.									
100	0.9783	0.9780	0.9777	0.9774	0.9770	0.9767	0.9763	0.9759	0.9757	0.9754
101	0.9778	0.9775	0.9772	0.9768	0.9764	0.9761	0.9757	0.9753	0.9751	0.9748
102	0.9772	0.9769	0.9766	0.9762	0.9759	0.9755	0.9751	0.9747	0.9745	0.9741
103	0.9767	0.9764	0.9760	0.9757	0.9753	0.9749	0.9745	0.9741	0.9738	0.9735
104	0.9762	0.9758	0.9755	0.9751	0.9747	0.9743	0.9739	0.9735	0.9732	0.9729
105	0.9756	0.9753	0.9749	0.9745	0.9741	0.9737	0.9733	0.9729	0.9726	0.9723
106	0.9751	0.9747	0.9744	0.9740	0.9736	0.9731	0.9727	0.9723	0.9720	0.9717
107	0.9745	0.9742	0.9738	0.9734	0.9730	0.9726	0.9721	0.9717	0.9714	0.9711
108	0.9740	0.9736	0.9732	0.9728	0.9724	0.9720	0.9715	0.9711	0.9708	0.9704
109	0.9734	0.9731	0.9727	0.9723	0.9718	0.9714	0.9710	0.9705	0.9702	0.9698
110	0.9729	0.9725	0.9721	0.9717	0.9713	0.9708	0.9704	0.9699	0.9696	0.9692
111	0.9724	0.9720	0.9716	0.9711	0.9707	0.9702	0.9698	0.9693	0.9690	0.9686
112	0.9718	0.9714	0.9710	0.9706	0.9701	0.9696	0.9692	0.9687	0.9683	0.9680
113	0.9713	0.9709	0.9704	0.9700	0.9695	0.9690	0.9686	0.9681	0.9677	0.9673
114	0.9707	0.9703	0.9699	0.9694	0.9689	0.9685	0.9680	0.9675	0.9671	0.9667
115	0.9702	0.9698	0.9693	0.9689	0.9684	0.9679	0.9674	0.9669	0.9665	0.9661
116	0.9696	0.9692	0.9688	0.9683	0.9678	0.9673	0.9668	0.9663	0.9659	0.9655
117	0.9691	0.9687	0.9682	0.9677	0.9672	0.9667	0.9662	0.9657	0.9653	0.9649
118	0.9686	0.9681	0.9676	0.9671	0.9666	0.9661	0.9656	0.9651	0.9647	0.9642
119	0.9680	0.9676	0.9671	0.9666	0.9661	0.9655	0.9650	0.9645	0.9641	0.9636
120	0.9675	0.9670	0.9665	0.9660	0.9655	0.9649	0.9644	0.9639	0.9634	0.9630
121	0.9669	0.9664	0.9660	0.9654	0.9649	0.9643	0.9638	0.9633	0.9628	0.9624
122	0.9664	0.9659	0.9654	0.9649	0.9643	0.9638	0.9632	0.9626	0.9622	0.9618
123	0.9658	0.9653	0.9648	0.9643	0.9637	0.9632	0.9626	0.9620	0.9616	0.9611
124	0.9653	0.9648	0.9643	0.9637	0.9632	0.9626	0.9620	0.9614	0.9610	0.9605
125	0.9647	0.9642	0.9637	0.9632	0.9626	0.9620	0.9614	0.9608	0.9604	0.9599
126	0.9642	0.9637	0.9632	0.9626	0.9620	0.9614	0.9608	0.9602	0.9598	0.9593
127	0.9637	0.9631	0.9626	0.9620	0.9614	0.9608	0.9602	0.9596	0.9592	0.9587
128	0.9631	0.9626	0.9620	0.9615	0.9608	0.9602	0.9596	0.9590	0.9585	0.9580
129	0.9626	0.9620	0.9615	0.9609	0.9603	0.9596	0.9590	0.9584	0.9579	0.9574
130	0.9620	0.9615	0.9609	0.9603	0.9597	0.9591	0.9584	0.9578	0.9573	0.9568
131	0.9615	0.9609	0.9604	0.9597	0.9591	0.9585	0.9578	0.9572	0.9567	0.9562
132	0.9609	0.9604	0.9598	0.9592	0.9585	0.9579	0.9572	0.9566	0.9561	0.9556
133	0.9604	0.9598	0.9592	0.9586	0.9580	0.9573	0.9566	0.9560	0.9555	0.9549
134	0.9598	0.9593	0.9587	0.9580	0.9574	0.9567	0.9560	0.9554	0.9549	0.9543
135	0.9593	0.9587	0.9581	0.9575	0.9568	0.9561	0.9554	0.9548	0.9542	0.9537
136	0.9588	0.9582	0.9576	0.9569	0.9562	0.9555	0.9548	0.9542	0.9536	0.9531
137	0.9582	0.9576	0.9570	0.9563	0.9556	0.9549	0.9542	0.9535	0.9530	0.9524
138	0.9577	0.9571	0.9564	0.9558	0.9551	0.9543	0.9537	0.9529	0.9524	0.9518
139	0.9571	0.9565	0.9559	0.9552	0.9545	0.9538	0.9531	0.9523	0.9518	0.9512
140	0.9566	0.9559	0.9553	0.9546	0.9539	0.9532	0.9525	0.9517	0.9512	0.9506
141	0.9560	0.9554	0.9548	0.9540	0.9533	0.9526	0.9519	0.9511	0.9506	0.9500
142	0.9555	0.9548	0.9542	0.9535	0.9527	0.9520	0.9513	0.9505	0.9499	0.9493
143	0.9549	0.9543	0.9536	0.9529	0.9522	0.9514	0.9507	0.9499	0.9493	0.9487
144	0.9544	0.9537	0.9531	0.9523	0.9516	0.9508	0.9501	0.9493	0.9487	0.9481
145	0.9538	0.9532	0.9525	0.9518	0.9510	0.9502	0.9495	0.9487	0.9481	0.9475
146	0.9533	0.9526	0.9519	0.9512	0.9504	0.9496	0.9489	0.9481	0.9475	0.9468
147	0.9528	0.9521	0.9514	0.9506	0.9498	0.9490	0.9483	0.9475	0.9469	0.9462
148	0.9522	0.9515	0.9508	0.9500	0.9493	0.9485	0.9477	0.9469	0.9462	0.9456
149	0.9517	0.9510	0.9503	0.9495	0.9487	0.9479	0.9471	0.9463	0.9456	0.9450
150	0.9511	0.9504	0.9497	0.9489	0.9481	0.9473	0.9465	0.9456	0.9450	0.9443

603

Table 6

Volume Reduction to 60° F.

60-69° API

0-50° F.

Observed Temperature, °F.	API Gravity at 60° F.									
	60	61	62	63	64	65	66	67	68	69
	Factor for Reducing Volume to 60° F.									
0	1.0370	1.0374	1.0378	1.0382	1.0386	1.0390	1.0395	1.0399	1.0403	1.0407
1	1.0364	1.0368	1.0372	1.0376	1.0380	1.0384	1.0388	1.0392	1.0396	1.0400
2	1.0358	1.0362	1.0366	1.0370	1.0374	1.0378	1.0382	1.0386	1.0390	1.0394
3	1.0351	1.0355	1.0359	1.0363	1.0367	1.0371	1.0375	1.0379	1.0383	1.0387
4	1.0345	1.0349	1.0353	1.0357	1.0361	1.0365	1.0368	1.0372	1.0376	1.0380
5	1.0339	1.0343	1.0347	1.0351	1.0354	1.0358	1.0362	1.0366	1.0370	1.0373
6	1.0333	1.0337	1.0340	1.0344	1.0348	1.0352	1.0355	1.0359	1.0363	1.0367
7	1.0327	1.0331	1.0334	1.0338	1.0342	1.0345	1.0349	1.0353	1.0356	1.0360
8	1.0321	1.0324	1.0328	1.0332	1.0335	1.0339	1.0342	1.0346	1.0350	1.0353
9	1.0315	1.0318	1.0322	1.0325	1.0329	1.0332	1.0336	1.0339	1.0343	1.0346
10	1.0308	1.0312	1.0315	1.0319	1.0322	1.0326	1.0329	1.0333	1.0336	1.0340
11	1.0302	1.0306	1.0309	1.0313	1.0316	1.0319	1.0323	1.0326	1.0329	1.0333
12	1.0296	1.0300	1.0303	1.0306	1.0310	1.0313	1.0316	1.0319	1.0323	1.0326
13	1.0290	1.0293	1.0297	1.0300	1.0303	1.0306	1.0310	1.0313	1.0316	1.0319
14	1.0284	1.0287	1.0290	1.0293	1.0297	1.0300	1.0303	1.0306	1.0309	1.0313
15	1.0278	1.0281	1.0284	1.0287	1.0290	1.0293	1.0297	1.0300	1.0303	1.0306
16	1.0272	1.0275	1.0278	1.0281	1.0284	1.0287	1.0290	1.0293	1.0296	1.0299
17	1.0265	1.0268	1.0271	1.0274	1.0277	1.0280	1.0283	1.0286	1.0289	1.0292
18	1.0259	1.0262	1.0265	1.0268	1.0271	1.0274	1.0277	1.0280	1.0283	1.0286
19	1.0253	1.0256	1.0259	1.0262	1.0265	1.0267	1.0270	1.0273	1.0276	1.0279
20	1.0247	1.0250	1.0253	1.0255	1.0258	1.0261	1.0264	1.0267	1.0269	1.0272
21	1.0241	1.0244	1.0246	1.0249	1.0252	1.0254	1.0257	1.0260	1.0263	1.0265
22	1.0235	1.0237	1.0240	1.0243	1.0245	1.0248	1.0251	1.0253	1.0256	1.0259
23	1.0229	1.0231	1.0234	1.0236	1.0239	1.0241	1.0244	1.0247	1.0249	1.0252
24	1.0222	1.0225	1.0227	1.0230	1.0232	1.0235	1.0237	1.0240	1.0243	1.0245
25	1.0216	1.0219	1.0221	1.0224	1.0226	1.0228	1.0231	1.0233	1.0236	1.0238
26	1.0210	1.0212	1.0215	1.0217	1.0220	1.0222	1.0224	1.0227	1.0229	1.0231
27	1.0204	1.0206	1.0209	1.0211	1.0213	1.0215	1.0218	1.0220	1.0222	1.0225
28	1.0198	1.0200	1.0202	1.0204	1.0207	1.0209	1.0211	1.0213	1.0216	1.0218
29	1.0192	1.0194	1.0196	1.0198	1.0200	1.0202	1.0205	1.0207	1.0209	1.0211
30	1.0185	1.0188	1.0190	1.0192	1.0194	1.0196	1.0198	1.0200	1.0202	1.0204
31	1.0179	1.0181	1.0183	1.0185	1.0187	1.0189	1.0191	1.0194	1.0196	1.0198
32	1.0173	1.0175	1.0177	1.0179	1.0181	1.0183	1.0185	1.0187	1.0189	1.0191
33	1.0167	1.0169	1.0171	1.0173	1.0175	1.0176	1.0178	1.0180	1.0182	1.0184
34	1.0161	1.0163	1.0164	1.0166	1.0168	1.0170	1.0172	1.0174	1.0175	1.0177
35	1.0155	1.0156	1.0158	1.0160	1.0162	1.0163	1.0165	1.0167	1.0169	1.0170
36	1.0148	1.0150	1.0152	1.0154	1.0155	1.0157	1.0159	1.0160	1.0162	1.0164
37	1.0142	1.0144	1.0146	1.0147	1.0149	1.0150	1.0152	1.0154	1.0155	1.0157
38	1.0136	1.0138	1.0139	1.0141	1.0142	1.0144	1.0145	1.0147	1.0148	1.0150
39	1.0130	1.0131	1.0133	1.0134	1.0136	1.0137	1.0139	1.0140	1.0142	1.0143
40	1.0124	1.0125	1.0127	1.0128	1.0129	1.0131	1.0132	1.0134	1.0135	1.0136
41	1.0118	1.0119	1.0120	1.0122	1.0123	1.0124	1.0126	1.0127	1.0128	1.0130
42	1.0111	1.0113	1.0114	1.0115	1.0116	1.0118	1.0119	1.0120	1.0122	1.0123
43	1.0105	1.0106	1.0108	1.0109	1.0110	1.0111	1.0112	1.0114	1.0115	1.0116
44	1.0099	1.0100	1.0101	1.0102	1.0104	1.0105	1.0106	1.0107	1.0108	1.0109
45	1.0093	1.0094	1.0095	1.0096	1.0097	1.0098	1.0099	1.0100	1.0101	1.0102
46	1.0087	1.0088	1.0089	1.0090	1.0091	1.0092	1.0093	1.0094	1.0095	1.0096
47	1.0081	1.0081	1.0082	1.0083	1.0084	1.0085	1.0086	1.0087	1.0088	1.0089
48	1.0074	1.0075	1.0076	1.0077	1.0078	1.0079	1.0079	1.0080	1.0081	1.0082
49	1.0068	1.0069	1.0070	1.0070	1.0071	1.0072	1.0073	1.0074	1.0074	1.0075
50	1.0062	1.0063	1.0063	1.0064	1.0065	1.0065	1.0066	1.0067	1.0068	1.0068

601

Table 6

60-69° API Volume Reduction to 60° F.

50-100° F.

Observed Temperature, °F.	API Gravity at 60° F.									
	60	61	62	63	64	65	66	67	68	69
	Factor for Reducing Volume to 60° F.									
50	1.0062	1.0063	1.0063	1.0064	1.0065	1.0065	1.0066	1.0067	1.0068	1.0068
51	1.0056	1.0056	1.0057	1.0058	1.0058	1.0059	1.0060	1.0060	1.0061	1.0061
52	1.0050	1.0050	1.0051	1.0051	1.0052	1.0052	1.0053	1.0054	1.0054	1.0055
53	1.0043	1.0044	1.0044	1.0045	1.0045	1.0046	1.0046	1.0047	1.0047	1.0048
54	1.0037	1.0038	1.0038	1.0038	1.0039	1.0039	1.0040	1.0040	1.0041	1.0041
55	1.0031	1.0031	1.0032	1.0032	1.0032	1.0033	1.0033	1.0033	1.0034	1.0034
56	1.0025	1.0025	1.0025	1.0026	1.0026	1.0026	1.0026	1.0027	1.0027	1.0027
57	1.0019	1.0019	1.0019	1.0019	1.0019	1.0020	1.0020	1.0020	1.0020	1.0021
58	1.0012	1.0013	1.0013	1.0013	1.0013	1.0013	1.0013	1.0013	1.0014	1.0014
59	1.0006	1.0006	1.0006	1.0006	1.0006	1.0007	1.0007	1.0007	1.0007	1.0007
60	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
61	0.9994	0.9994	0.9994	0.9994	0.9994	0.9993	0.9993	0.9993	0.9993	0.9993
62	0.9988	0.9987	0.9987	0.9987	0.9987	0.9987	0.9987	0.9987	0.9986	0.9986
63	0.9981	0.9981	0.9981	0.9981	0.9981	0.9980	0.9980	0.9980	0.9980	0.9979
64	0.9975	0.9975	0.9975	0.9974	0.9974	0.9974	0.9973	0.9973	0.9973	0.9973
65	0.9969	0.9969	0.9968	0.9968	0.9968	0.9967	0.9967	0.9966	0.9966	0.9966
66	0.9963	0.9962	0.9962	0.9961	0.9961	0.9961	0.9960	0.9960	0.9959	0.9959
67	0.9957	0.9956	0.9956	0.9955	0.9955	0.9954	0.9954	0.9953	0.9953	0.9952
68	0.9950	0.9950	0.9949	0.9949	0.9948	0.9948	0.9947	0.9946	0.9946	0.9945
69	0.9944	0.9943	0.9943	0.9942	0.9942	0.9941	0.9940	0.9940	0.9939	0.9938
70	0.9938	0.9937	0.9937	0.9936	0.9935	0.9934	0.9934	0.9933	0.9932	0.9932
71	0.9932	0.9931	0.9930	0.9929	0.9929	0.9928	0.9927	0.9926	0.9925	0.9925
72	0.9926	0.9925	0.9924	0.9923	0.9922	0.9921	0.9920	0.9919	0.9919	0.9918
73	0.9919	0.9918	0.9917	0.9916	0.9916	0.9915	0.9914	0.9913	0.9912	0.9911
74	0.9913	0.9912	0.9911	0.9910	0.9909	0.9908	0.9907	0.9906	0.9905	0.9904
75	0.9907	0.9906	0.9905	0.9904	0.9903	0.9901	0.9900	0.9899	0.9898	0.9897
76	0.9901	0.9899	0.9898	0.9897	0.9896	0.9895	0.9894	0.9893	0.9891	0.9890
77	0.9894	0.9893	0.9892	0.9891	0.9890	0.9888	0.9887	0.9886	0.9885	0.9883
78	0.9888	0.9887	0.9886	0.9884	0.9883	0.9882	0.9880	0.9879	0.9878	0.9877
79	0.9882	0.9881	0.9879	0.9878	0.9877	0.9875	0.9874	0.9872	0.9871	0.9870
80	0.9876	0.9874	0.9873	0.9871	0.9870	0.9869	0.9867	0.9866	0.9864	0.9863
81	0.9870	0.9868	0.9866	0.9865	0.9863	0.9862	0.9860	0.9859	0.9857	0.9856
82	0.9863	0.9862	0.9860	0.9859	0.9857	0.9855	0.9854	0.9852	0.9851	0.9849
83	0.9857	0.9855	0.9854	0.9852	0.9850	0.9849	0.9847	0.9845	0.9844	0.9842
84	0.9851	0.9849	0.9847	0.9846	0.9844	0.9842	0.9840	0.9839	0.9837	0.9835
85	0.9845	0.9843	0.9841	0.9839	0.9837	0.9836	0.9834	0.9832	0.9830	0.9828
86	0.9838	0.9836	0.9835	0.9833	0.9831	0.9829	0.9827	0.9825	0.9823	0.9822
87	0.9832	0.9830	0.9828	0.9826	0.9824	0.9822	0.9820	0.9819	0.9817	0.9815
88	0.9826	0.9824	0.9822	0.9820	0.9818	0.9816	0.9814	0.9812	0.9810	0.9808
89	0.9820	0.9818	0.9815	0.9813	0.9811	0.9809	0.9807	0.9805	0.9803	0.9801
90	0.9813	0.9811	0.9809	0.9807	0.9805	0.9803	0.9800	0.9798	0.9796	0.9794
91	0.9807	0.9805	0.9803	0.9800	0.9798	0.9796	0.9794	0.9792	0.9789	0.9787
92	0.9801	0.9799	0.9796	0.9794	0.9792	0.9789	0.9787	0.9785	0.9782	0.9780
93	0.9795	0.9792	0.9790	0.9788	0.9785	0.9783	0.9780	0.9778	0.9776	0.9773
94	0.9788	0.9786	0.9784	0.9781	0.9779	0.9776	0.9774	0.9771	0.9769	0.9766
95	0.9782	0.9780	0.9777	0.9775	0.9772	0.9770	0.9767	0.9765	0.9762	0.9759
96	0.9776	0.9773	0.9771	0.9768	0.9766	0.9763	0.9760	0.9758	0.9755	0.9753
97	0.9770	0.9767	0.9764	0.9762	0.9759	0.9756	0.9754	0.9751	0.9748	0.9746
98	0.9763	0.9761	0.9758	0.9755	0.9752	0.9750	0.9747	0.9744	0.9741	0.9739
99	0.9757	0.9754	0.9752	0.9749	0.9746	0.9743	0.9740	0.9737	0.9735	0.9732
100	0.9751	0.9748	0.9745	0.9742	0.9739	0.9736	0.9734	0.9731	0.9728	0.9725

61G97

602

Table 6

Volume Reduction to 60° F.

60-69° API

100-150° F.

Observed Temperature, °F.	API Gravity at 60° F.									
	60	61	62	63	64	65	66	67	68	69
	Factor for Reducing Volume to 60° F.									
100	0.9751	0.9748	0.9745	0.9742	0.9739	0.9736	0.9734	0.9731	0.9728	0.9725
101	0.9745	0.9742	0.9739	0.9736	0.9733	0.9730	0.9727	0.9724	0.9721	0.9718
102	0.9738	0.9735	0.9732	0.9729	0.9726	0.9723	0.9720	0.9717	0.9714	0.9711
103	0.9732	0.9729	0.9726	0.9723	0.9720	0.9717	0.9713	0.9710	0.9707	0.9704
104	0.9726	0.9723	0.9720	0.9716	0.9713	0.9710	0.9707	0.9704	0.9700	0.9697
105	0.9720	0.9716	0.9713	0.9710	0.9707	0.9703	0.9700	0.9697	0.9694	0.9690
106	0.9713	0.9710	0.9707	0.9703	0.9700	0.9697	0.9693	0.9690	0.9687	0.9683
107	0.9707	0.9704	0.9700	0.9697	0.9694	0.9690	0.9687	0.9683	0.9680	0.9676
108	0.9701	0.9697	0.9694	0.9690	0.9687	0.9683	0.9680	0.9676	0.9673	0.9670
109	0.9695	0.9691	0.9688	0.9684	0.9680	0.9677	0.9673	0.9670	0.9666	0.9663
110	0.9688	0.9685	0.9681	0.9677	0.9674	0.9670	0.9667	0.9663	0.9659	0.9656
111	0.9682	0.9678	0.9675	0.9671	0.9667	0.9664	0.9660	0.9656	0.9652	0.9649
112	0.9676	0.9672	0.9668	0.9664	0.9661	0.9657	0.9653	0.9649	0.9646	0.9642
113	0.9670	0.9666	0.9662	0.9658	0.9654	0.9650	0.9646	0.9643	0.9639	0.9635
114	0.9663	0.9659	0.9655	0.9651	0.9648	0.9644	0.9640	0.9636	0.9632	0.9628
115	0.9657	0.9653	0.9649	0.9645	0.9641	0.9637	0.9633	0.9629	0.9625	0.9621
116	0.9651	0.9647	0.9643	0.9638	0.9634	0.9630	0.9626	0.9622	0.9618	0.9614
117	0.9644	0.9640	0.9636	0.9632	0.9628	0.9624	0.9620	0.9615	0.9611	0.9607
118	0.9638	0.9634	0.9630	0.9625	0.9621	0.9617	0.9613	0.9609	0.9604	0.9600
119	0.9632	0.9628	0.9623	0.9619	0.9615	0.9610	0.9606	0.9602	0.9597	0.9593
120	0.9626	0.9621	0.9617	0.9612	0.9608	0.9604	0.9599	0.9595	0.9591	0.9586
121	0.9619	0.9615	0.9610	0.9606	0.9602	0.9597	0.9593	0.9588	0.9584	0.9579
122	0.9613	0.9609	0.9604	0.9599	0.9595	0.9590	0.9586	0.9581	0.9577	0.9572
123	0.9607	0.9602	0.9598	0.9593	0.9588	0.9584	0.9579	0.9575	0.9570	0.9565
124	0.9601	0.9596	0.9591	0.9586	0.9582	0.9577	0.9572	0.9568	0.9563	0.9558
125	0.9594	0.9589	0.9585	0.9580	0.9575	0.9570	0.9566	0.9561	0.9556	0.9551
126	0.9588	0.9583	0.9578	0.9573	0.9569	0.9564	0.9559	0.9554	0.9549	0.9544
127	0.9582	0.9577	0.9572	0.9567	0.9562	0.9557	0.9552	0.9547	0.9542	0.9538
128	0.9575	0.9570	0.9565	0.9560	0.9555	0.9550	0.9545	0.9541	0.9536	0.9531
129	0.9569	0.9564	0.9559	0.9554	0.9549	0.9544	0.9539	0.9534	0.9529	0.9524
130	0.9563	0.9558	0.9553	0.9547	0.8542	0.9537	0.9532	0.9527	0.9522	0.9517
131	0.9557	0.9551	0.9546	0.9541	0.9536	0.9530	0.9525	0.9520	0.9515	0.9510
132	0.9550	0.9545	0.9540	0.9534	0.9529	0.9524	0.9519	0.9513	0.9508	0.9503
133	0.9544	0.9539	0.9533	0.9528	0.9522	0.9517	0.9512	0.9506	0.9501	0.9496
134	0.9538	0.9532	0.9527	0.9521	0.9516	0.9510	0.9505	0.9500	0.9494	0.9489
135	0.9531	0.9526	0.9520	0.9515	0.9509	0.9504	0.9498	0.9493	0.9487	0.9482
136	0.9525	0.9519	0.9514	0.9508	0.9503	0.9497	0.9491	0.9486	0.9480	0.9475
137	0.9519	0.9513	0.9507	0.9502	0.9496	0.9490	0.9485	0.9479	0.9473	0.9468
138	0.9512	0.9507	0.9501	0.9495	0.9489	0.9484	0.9478	0.9472	0.9466	0.9461
139	0.9506	0.9500	0.9495	0.9489	0.9483	0.9477	0.9471	0.9465	0.9460	0.9454
140	0.9500	0.9494	0.9488	0.9482	0.9476	0.9470	0.9464	0.9459	0.9453	0.9447
141	0.9494	0.9488	0.9482	0.9476	0.9470	0.9464	0.9458	0.9452	0.9446	0.9440
142	0.9487	0.9481	0.9475	0.9469	0.9463	0.9457	0.9451	0.9445	0.9439	0.9433
143	0.9481	0.9475	0.9469	0.9463	0.9456	0.9450	0.9444	0.9438	0.9432	0.9426
144	0.9475	0.9468	0.9462	0.9456	0.9450	0.9444	0.9437	0.9431	0.9425	0.9419
145	0.9468	0.9462	0.9456	0.9449	0.9443	0.9437	0.9431	0.9424	0.9418	0.9412
146	0.9462	0.9456	0.9449	0.9443	0.9437	0.9430	0.9424	0.9418	0.9411	0.9405
147	0.9456	0.9449	0.9443	0.9436	0.9430	0.9424	0.9417	0.9411	0.9404	0.9398
148	0.9449	0.9443	0.9436	0.9430	0.9423	0.9417	0.9410	0.9404	0.9397	0.9391
149	0.9443	0.9436	0.9430	0.9423	0.9417	0.9410	0.9404	0.9397	0.9390	0.9384
150	0.9437	0.9430	0.9423	0.9417	0.9410	0.9403	0.9397	0.9390	0.9383	0.9377

611

Table 6

70-79° API Volume Reduction to 60° F.

0-50° F.

Observed Temperature, °F.	API Gravity at 60° F.									
	70	71	72	73	74	75	76	77	78	79
	Factor for Reducing Volume to 60° F.									
0	1.0411	1.0415	1.0419	1.0423	1.0427	1.0431	1.0435	1.0440	1.0444	1.0448
1	1.0404	1.0408	1.0412	1.0416	1.0420	1.0424	1.0428	1.0432	1.0437	1.0441
2	1.0398	1.0402	1.0405	1.0409	1.0413	1.0417	1.0421	1.0425	1.0429	1.0433
3	1.0391	1.0395	1.0399	1.0402	1.0406	1.0410	1.0414	1.0418	1.0422	1.0426
4	1.0384	1.0388	1.0392	1.0395	1.0399	1.0403	1.0407	1.0411	1.0415	1.0418
5	1.0377	1.0381	1.0385	1.0388	1.0392	1.0396	1.0399	1.0403	1.0407	1.0411
6	1.0370	1.0374	1.0378	1.0381	1.0385	1.0389	1.0392	1.0396	1.0400	1.0404
7	1.0364	1.0367	1.0371	1.0374	1.0378	1.0381	1.0385	1.0389	1.0393	1.0396
8	1.0357	1.0360	1.0364	1.0367	1.0371	1.0374	1.0378	1.0382	1.0385	1.0389
9	1.0350	1.0354	1.0357	1.0360	1.0364	1.0367	1.0371	1.0374	1.0378	1.0381
10	1.0343	1.0347	1.0350	1.0353	1.0357	1.0360	1.0363	1.0367	1.0371	1.0374
11	1.0336	1.0340	1.0343	1.0346	1.0350	1.0353	1.0356	1.0360	1.0363	1.0367
12	1.0329	1.0333	1.0336	1.0339	1.0343	1.0346	1.0349	1.0352	1.0356	1.0359
13	1.0323	1.0326	1.0329	1.0332	1.0335	1.0339	1.0342	1.0345	1.0348	1.0352
14	1.0316	1.0319	1.0322	1.0325	1.0328	1.0331	1.0335	1.0338	1.0341	1.0344
15	1.0309	1.0312	1.0315	1.0318	1.0321	1.0324	1.0327	1.0331	1.0334	1.0337
16	1.0302	1.0305	1.0308	1.0311	1.0314	1.0317	1.0320	1.0323	1.0326	1.0329
17	1.0295	1.0298	1.0301	1.0304	1.0307	1.0310	1.0313	1.0316	1.0319	1.0322
18	1.0289	1.0292	1.0294	1.0297	1.0300	1.0303	1.0306	1.0309	1.0312	1.0315
19	1.0282	1.0285	1.0287	1.0290	1.0293	1.0296	1.0298	1.0301	1.0304	1.0307
20	1.0275	1.0278	1.0280	1.0283	1.0286	1.0289	1.0291	1.0294	1.0297	1.0300
21	1.0268	1.0271	1.0273	1.0276	1.0279	1.0281	1.0284	1.0287	1.0290	1.0292
22	1.0261	1.0264	1.0266	1.0269	1.0272	1.0274	1.0277	1.0280	1.0282	1.0285
23	1.0254	1.0257	1.0259	1.0262	1.0264	1.0267	1.0270	1.0272	1.0275	1.0277
24	1.0248	1.0250	1.0253	1.0255	1.0257	1.0260	1.0262	1.0265	1.0267	1.0270
25	1.0241	1.0243	1.0246	1.0248	1.0250	1.0253	1.0255	1.0258	1.0260	1.0262
26	1.0234	1.0236	1.0239	1.0241	1.0243	1.0245	1.0248	1.0250	1.0253	1.0255
27	1.0227	1.0229	1.0232	1.0234	1.0236	1.0238	1.0241	1.0243	1.0245	1.0248
28	1.0220	1.0222	1.0225	1.0227	1.0229	1.0231	1.0233	1.0236	1.0238	1.0240
29	1.0213	1.0216	1.0218	1.0220	1.0222	1.0224	1.0226	1.0228	1.0230	1.0233
30	1.0206	1.0209	1.0211	1.0213	1.0215	1.0217	1.0219	1.0221	1.0223	1.0225
31	1.0200	1.0202	1.0204	1.0206	1.0208	1.0210	1.0212	1.0214	1.0216	1.0218
32	1.0193	1.0195	1.0197	1.0199	1.0200	1.0202	1.0204	1.0206	1.0208	1.0210
33	1.0186	1.0188	1.0190	1.0191	1.0193	1.0195	1.0197	1.0199	1.0201	1.0203
34	1.0179	1.0181	1.0183	1.0184	1.0186	1.0188	1.0190	1.0192	1.0193	1.0195
35	1.0172	1.0174	1.0176	1.0177	1.0179	1.0181	1.0182	1.0184	1.0186	1.0188
36	1.0165	1.0167	1.0169	1.0170	1.0172	1.0174	1.0175	1.0177	1.0179	1.0180
37	1.0158	1.0160	1.0162	1.0163	1.0165	1.0166	1.0168	1.0170	1.0171	1.0173
38	1.0152	1.0153	1.0155	1.0156	1.0158	1.0159	1.0161	1.0162	1.0164	1.0165
39	1.0145	1.0146	1.0148	1.0149	1.0150	1.0152	1.0153	1.0155	1.0156	1.0158
40	1.0138	1.0139	1.0141	1.0142	1.0143	1.0145	1.0146	1.0148	1.0149	1.0150
41	1.0131	1.0132	1.0134	1.0135	1.0136	1.0138	1.0139	1.0140	1.0142	1.0143
42	1.0124	1.0125	1.0127	1.0128	1.0129	1.0130	1.0132	1.0133	1.0134	1.0135
43	1.0117	1.0118	1.0120	1.0121	1.0122	1.0123	1.0124	1.0125	1.0127	1.0128
44	1.0110	1.0111	1.0113	1.0114	1.0115	1.0116	1.0117	1.0118	1.0119	1.0120
45	1.0103	1.0105	1.0106	1.0107	1.0108	1.0109	1.0110	1.0111	1.0112	1.0113
46	1.0097	1.0098	1.0099	1.0099	1.0100	1.0101	1.0102	1.0103	1.0104	1.0105
47	1.0090	1.0091	1.0091	1.0092	1.0093	1.0094	1.0095	1.0096	1.0097	1.0098
48	1.0083	1.0084	1.0084	1.0085	1.0086	1.0087	1.0088	1.0089	1.0089	1.0090
49	1.0076	1.0077	1.0077	1.0078	1.0079	1.0080	1.0080	1.0081	1.0082	1.0083
50	1.0069	1.0070	1.0070	1.0071	1.0072	1.0072	1.0073	1.0074	1.0075	1.0075

Table 6

Volume Reduction to 60° F.

70-79° API

50-100° F.

Observed Temperature, °F.	API Gravity at 60° F.									
	70	71	72	73	74	75	76	77	78	79
	Factor for Reducing Volume to 60° F.									
50	1.0069	1.0070	1.0070	1.0071	1.0072	1.0072	1.0073	1.0074	1.0075	1.0075
51	1.0062	1.0063	1.0063	1.0064	1.0065	1.0066	1.0066	1.0067	1.0067	1.0068
52	1.0055	1.0056	1.0056	1.0057	1.0057	1.0058	1.0059	1.0059	1.0060	1.0060
53	1.0048	1.0049	1.0049	1.0050	1.0050	1.0051	1.0051	1.0052	1.0052	1.0053
54	1.0041	1.0042	1.0042	1.0043	1.0043	1.0044	1.0044	1.0044	1.0045	1.0045
55	1.0035	1.0035	1.0035	1.0036	1.0036	1.0036	1.0037	1.0037	1.0037	1.0038
56	1.0028	1.0028	1.0028	1.0028	1.0029	1.0029	1.0029	1.0030	1.0030	1.0030
57	1.0021	1.0021	1.0021	1.0021	1.0022	1.0022	1.0022	1.0022	1.0022	1.0023
58	1.0014	1.0014	1.0014	1.0014	1.0014	1.0015	1.0015	1.0015	1.0015	1.0015
59	1.0007	1.0007	1.0007	1.0007	1.0007	1.0007	1.0007	1.0007	1.0007	1.0008
60	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
61	0.9993	0.9993	0.9993	0.9993	0.9993	0.9993	0.9993	0.9993	0.9993	0.9992
62	0.9986	0.9986	0.9986	0.9986	0.9986	0.9985	0.9985	0.9985	0.9985	0.9985
63	0.9979	0.9979	0.9979	0.9979	0.9978	0.9978	0.9978	0.9978	0.9978	0.9977
64	0.9972	0.9972	0.9972	0.9971	0.9971	0.9971	0.9971	0.9970	0.9970	0.9970
65	0.9965	0.9965	0.9965	0.9964	0.9964	0.9964	0.9963	0.9963	0.9963	0.9962
66	0.9958	0.9958	0.9958	0.9957	0.9957	0.9956	0.9956	0.9956	0.9955	0.9955
67	0.9952	0.9951	0.9951	0.9950	0.9950	0.9949	0.9949	0.9948	0.9948	0.9947
68	0.9945	0.9944	0.9944	0.9943	0.9942	0.9942	0.9941	0.9941	0.9940	0.9940
69	0.9938	0.9937	0.9936	0.9936	0.9935	0.9935	0.9934	0.9933	0.9933	0.9932
70	0.9931	0.9930	0.9929	0.9929	0.9928	0.9927	0.9927	0.9926	0.9925	0.9924
71	0.9924	0.9923	0.9922	0.9922	0.9921	0.9920	0.9919	0.9918	0.9918	0.9917
72	0.9917	0.9916	0.9915	0.9914	0.9914	0.9913	0.9912	0.9911	0.9910	0.9909
73	0.9910	0.9909	0.9908	0.9907	0.9906	0.9905	0.9905	0.9904	0.9903	0.9902
74	0.9903	0.9902	0.9901	0.9900	0.9899	0.9898	0.9897	0.9896	0.9895	0.9894
75	0.9896	0.9895	0.9894	0.9893	0.9892	0.9891	0.9890	0.9889	0.9888	0.9887
76	0.9889	0.9888	0.9887	0.9886	0.9885	0.9884	0.9882	0.9881	0.9880	0.9879
77	0.9882	0.9881	0.9880	0.9879	0.9877	0.9876	0.9875	0.9874	0.9873	0.9871
78	0.9875	0.9874	0.9873	0.9871	0.9870	0.9869	0.9868	0.9866	0.9865	0.9864
79	0.9868	0.9867	0.9866	0.9864	0.9863	0.9862	0.9860	0.9859	0.9858	0.9856
80	0.9861	0.9860	0.9859	0.9857	0.9856	0.9854	0.9853	0.9851	0.9850	0.9849
81	0.9854	0.9853	0.9851	0.9850	0.9849	0.9847	0.9846	0.9844	0.9843	0.9841
82	0.9847	0.9846	0.9844	0.9843	0.9841	0.9840	0.9839	0.9837	0.9835	0.9833
83	0.9841	0.9839	0.9837	0.9836	0.9834	0.9832	0.9831	0.9829	0.9827	0.9826
84	0.9834	0.9832	0.9830	0.9828	0.9827	0.9825	0.9823	0.9822	0.9820	0.9818
85	0.9827	0.9825	0.9823	0.9821	0.9820	0.9818	0.9816	0.9814	0.9812	0.9811
86	0.9820	0.9818	0.9816	0.9814	0.9812	0.9810	0.9809	0.9807	0.9805	0.9803
87	0.9813	0.9811	0.9809	0.9807	0.9805	0.9803	0.9801	0.9799	0.9797	0.9795
88	0.9806	0.9804	0.9802	0.9800	0.9798	0.9796	0.9794	0.9792	0.9790	0.9788
89	0.9799	0.9797	0.9795	0.9793	0.9791	0.9789	0.9786	0.9784	0.9782	0.9780
90	0.9792	0.9790	0.9787	0.9785	0.9783	0.9781	0.9779	0.9777	0.9775	0.9772
91	0.9785	0.9783	0.9780	0.9778	0.9776	0.9774	0.9772	0.9769	0.9767	0.9765
92	0.9778	0.9776	0.9773	0.9771	0.9769	0.9767	0.9764	0.9762	0.9760	0.9757
93	0.9771	0.9768	0.9766	0.9764	0.9762	0.9759	0.9757	0.9754	0.9752	0.9750
94	0.9764	0.9761	0.9759	0.9757	0.9754	0.9752	0.9749	0.9747	0.9744	0.9742
95	0.9757	0.9754	0.9752	0.9749	0.9747	0.9745	0.9742	0.9739	0.9737	0.9734
96	0.9750	0.9747	0.9745	0.9742	0.9740	0.9737	0.9735	0.9732	0.9729	0.9727
97	0.9743	0.9740	0.9738	0.9735	0.9732	0.9730	0.9727	0.9724	0.9722	0.9719
98	0.9736	0.9733	0.9731	0.9728	0.9725	0.9722	0.9720	0.9717	0.9714	0.9711
99	0.9729	0.9726	0.9723	0.9721	0.9718	0.9715	0.9712	0.9709	0.9707	0.9704
100	0.9722	0.9719	0.9716	0.9713	0.9711	0.9708	0.9705	0.9702	0.9699	0.9696

Table 6

70-79° API

Volume Reduction to 60° F.

100-150° F.

Observed Temperature, °F.	API Gravity at 60° F.									
	70	71	72	73	74	75	76	77	78	79
	Factor for Reducing Volume to 60° F.									
100	0.9722	0.9719	0.9716	0.9713	0.9711	0.9708	0.9705	0.9702	0.9699	0.9696
101	0.9715	0.9712	0.9709	0.9706	0.9703	0.9700	0.9698	0.9694	0.9691	0.9688
102	0.9708	0.9705	0.9702	0.9699	0.9696	0.9693	0.9690	0.9687	0.9684	0.9681
103	0.9701	0.9698	0.9695	0.9692	0.9689	0.9686	0.9683	0.9679	0.9676	0.9673
104	0.9694	0.9691	0.9688	0.9685	0.9681	0.9678	0.9675	0.9672	0.9669	0.9666
105	0.9687	0.9684	0.9681	0.9677	0.9674	0.9671	0.9668	0.9664	0.9661	0.9658
106	0.9680	0.9677	0.9673	0.9670	0.9667	0.9664	0.9660	0.9657	0.9654	0.9650
107	0.9673	0.9670	0.9666	0.9663	0.9660	0.9656	0.9653	0.9649	0.9646	0.9643
108	0.9666	0.9662	0.9659	0.9656	0.9652	0.9649	0.9646	0.9642	0.9638	0.9635
109	0.9659	0.9655	0.9652	0.9648	0.9645	0.9642	0.9638	0.9634	0.9631	0.9627
110	0.9652	0.9648	0.9645	0.9641	0.9638	0.9634	0.9631	0.9627	0.9623	0.9620
111	0.9645	0.9641	0.9638	0.9634	0.9630	0.9627	0.9623	0.9619	0.9616	0.9612
112	0.9638	0.9634	0.9630	0.9627	0.9623	0.9619	0.9616	0.9612	0.9608	0.9604
113	0.9631	0.9627	0.9623	0.9620	0.9616	0.9612	0.9608	0.9604	0.9600	0.9596
114	0.9624	0.9620	0.9616	0.9612	0.9608	0.9605	0.9601	0.9597	0.9593	0.9589
115	0.9617	0.9613	0.9609	0.9605	0.9601	0.9597	0.9593	0.9589	0.9585	0.9581
116	0.9610	0.9606	0.9602	0.9598	0.9594	0.9590	0.9586	0.9582	0.9578	0.9573
117	0.9603	0.9599	0.9595	0.9591	0.9587	0.9583	0.9578	0.9574	0.9570	0.9566
118	0.9596	0.9592	0.9587	0.9583	0.9579	0.9575	0.9571	0.9567	0.9562	0.9558
119	0.9589	0.9584	0.9580	0.9576	0.9572	0.9568	0.9564	0.9559	0.9555	0.9550
120	0.9582	0.9577	0.9573	0.9569	0.9565	0.9560	0.9556	0.9551	0.9547	0.9543
121	0.9575	0.9570	0.9566	0.9562	0.9557	0.9553	0.9549	0.9544	0.9539	0.9535
122	0.9568	0.9563	0.9559	0.9554	0.9550	0.9546	0.9541	0.9536	0.9532	0.9527
123	0.9561	0.9556	0.9552	0.9547	0.9543	0.9538	0.9534	0.9529	0.9524	0.9520
124	0.9554	0.9549	0.9544	0.9540	0.9535	0.9531	0.9526	0.9521	0.9517	0.9512
125	0.9547	0.9542	0.9537	0.9533	0.9528	0.9523	0.9519	0.9514	0.9509	0.9504
126	0.9540	0.9535	0.9530	0.9525	0.9521	0.9516	0.9511	0.9506	0.9501	0.9496
127	0.9533	0.9528	0.9523	0.9518	0.9513	0.9508	0.9504	0.9499	0.9494	0.9489
128	0.9526	0.9520	0.9516	0.9511	0.9506	0.9501	0.9496	0.9491	0.9486	0.9481
129	0.9518	0.9513	0.9508	0.9504	0.9499	0.9494	0.9489	0.9483	0.9478	0.9473
130	0.9511	0.9506	0.9501	0.9496	0.9491	0.9486	0.9481	0.9476	0.9471	0.9466
131	0.9504	0.9499	0.9494	0.9489	0.9484	0.9479	0.9474	0.9468	0.9463	0.9458
132	0.9497	0.9492	0.9487	0.9482	0.9477	0.9471	0.9466	0.9461	0.9455	0.9450
133	0.9490	0.9485	0.9480	0.9474	0.9469	0.9464	0.9459	0.9453	0.9448	0.9442
134	0.9483	0.9478	0.9472	0.9467	0.9462	0.9457	0.9451	0.9446	0.9440	0.9435
135	0.9476	0.9471	0.9465	0.9460	0.9454	0.9449	0.9444	0.9438	0.9432	0.9427
136	0.9469	0.9463	0.9458	0.9453	0.9447	0.9442	0.9436	0.9430	0.9425	0.9419
137	0.9462	0.9456	0.9451	0.9445	0.9440	0.9434	0.9429	0.9423	0.9417	0.9411
138	0.9455	0.9449	0.9444	0.9438	0.9432	0.9427	0.9421	0.9415	0.9409	0.9404
139	0.9448	0.9442	0.9436	0.9431	0.9425	0.9419	0.9414	0.9408	0.9402	0.9396
140	0.9441	0.9435	0.9429	0.9423	0.9418	0.9412	0.9406	0.9400	0.9304	0.9388
141	0.9434	0.9428	0.9422	0.9416	0.9410	0.9404	0.9399	0.9392	0.9386	0.9380
142	0.9427	0.9421	0.9415	0.9409	0.9403	0.9397	0.9391	0.9385	0.9379	0.9373
143	0.9420	0.9413	0.9407	0.9402	0.9396	0.9390	0.9384	0.9377	0.9371	0.9365
144	0.9413	0.9406	0.9400	0.9394	0.9389	0.9382	0.9376	0.9370	0.9363	0.9357
145	0.9405	0.9399	0.9393	0.9387	0.9381	0.9375	0.9369	0.9362	0.9356	0.9349
146	0.9398	0.9392	0.9386	0.9380	0.9373	0.9367	0.9361	0.9354	0.9348	0.9342
147	0.9391	0.9385	0.9379	0.9372	0.9366	0.9360	0.9353	0.9347	0.9340	0.9334
148	0.9384	0.9378	0.9371	0.9365	0.9359	0.9352	0.9346	0.9339	0.9333	0.9326
149	0.9377	0.9371	0.9364	0.9358	0.9351	0.9345	0.9338	0.9332	0.9325	0.9318
150	0.9370	0.9363	0.9357	0.9350	0.9344	0.9338	0.9331	0.9324	0.9317	0.9311

STRAPPING CHART*
500-BARREL TANK

	INNAGE	GALLONS		INNAGE	GALLONS		INNAGE	GALLONS
0'	1"	227	3'	0"	8,172	6'	0"	16,344
	2"	454		1"	8,399		1"	16,571
	3"	681		2"	8,626		2"	16,798
	4"	908		3"	8,853		3"	17,025
	5"	1,135		4"	9,080		4"	17,252
	6"	1,362		5"	9,307		5"	17,479
	7"	1,589		6"	9,534		6"	17,706
	8"	1,816		7"	9,761		7"	17,933
	9"	2,043		8"	9,988		8"	18,160
	10"	2,270		9"	10,215		9"	18,387
	11"	2,497		10"	10,442		10"	18,614
				11"	10,669		11"	18,841
1'	0"	2,724	4'	0"	10,896	7'	0"	19,061
	1"	2,951		1"	11,123		1"	19,295
	2"	3,178		2"	11,350		2"	19,522
	3"	3,405		3"	11,577		3"	19,749
	4"	3,632		4"	11,804		4"	19,976
	5"	3,859		5"	12,031		5"	20,203
	6"	4,086		6"	12,252		6"	20,430
	7"	4,313		7"	12,485		7"	20,657
	8"	4,540		8"	12,712		8"	20,884
	9"	4,767		9"	12,939		9"	21,111
	10"	4,994		10"	13,166		10"	21,338
	11"	5,221		11"	13,393		11"	21,565
2'	0"	5,448	5'	0"	13,620	8'	0"	21,793
	1"	5,675		1"	13,847		1"	22,019
	2"	5,902		2"	14,071			
	3"	6,129		3"	14,301			
	4"	6,356		4"	14,528		1/8"	28.375
	5"	6,583		5"	14,755		1/4"	56.750
	6"	6,810		6"	14,982		3/8"	85.125
	7"	7,037		7"	15,209		1/2"	113.500
	8"	7,264		8"	15,436		5/8"	141.875
	9"	7,491		9"	15,663		3/4"	170.250
	10"	7,718		10"	15,890		7/8"	198.625
	11"	7,945		11"	16,117			

VALVES, PIPES AND FITTINGS

PS-D-5-PFS

QMS 300.502

HANDOUT

INTRODUCTION:

Have you taken a close look at the valves, pipes and fittings that make up the pipeline at the P.T.F.? Do you know why different types of valves are located at different points throughout the system? This lesson will teach you the difference between the types of valves, pipes, and fittings: what they are used for and how to operate and maintain them.

OBJECTIVE:

As a result of this instruction and when provided with a Petroleum Storage Facility containing standard valves, pipes, and fittings, the student will be able to identify the different types of valves and fittings, perform inspections and operator maintenance, and identify the use and purpose of each valve and fitting used in Petroleum Pipeline Operations.

PART 1

You should now contact your instructor and tell him you are ready to see the film on valves. Pay close attention and you will get an idea of what the different types of valves are and how they operate in controlling fuel flow. After you have seen the film, go on to part 2 of this program.

PROPONENT DEPARTMENT: Petroleum and Field Services

May 1977

PS-D-5-PFS

QMS 300.502

PART 2

You should now be in the "Pipeline" study area of Building 11400. See the valves and pipes all around?

Gate Valves

Go to the gate valves (valves marked number 1 and 2). These are the type of valves used in a pipeline. As you will recall from the film, these valves have disks inside them which are raised and lowered by turning the handwheel on the top. When the handwheel is turned to the left (counter-clockwise) these disks are raised and allow fuel to flow through the valve. Turn the handwheel on valve # 1 counterclockwise all the way then look through the valve ports at the bottom. You should be able to see all the way through from one port to the other. Now turn the handwheel to the right (counterclockwise) till it stops. Look through the ports again--see how the disks block the opening? Now you know how a gate valve controls the flow of fuel: If the handwheel is turned counterclockwise the disks rise and fuel flows through the valve; when the handwheel is turned clockwise, the disks are lowered and blocks the fuel flow through the valve. Got it?

The only difference between valve # 1 and valve # 2 is:

Valve # 1 is a non-rising stem gate valve.
Valve # 2 is a rising stem gate valve.

The valve stem is the shaft with screw-like threads on it sticking up through the center of the handwheel -- see it? Well, on the rising stem gate valve when the handwheel is turned the valve stem rises and falls along with the disks. Turn the handwheel on valve # 2 and see for yourself.

This is the only difference between these two valves. Know why the rising and non rising stem gate valves work in basically the same way but are somewhat different?

If you had a security box built around a valve and the box had very little space between it and the top of the valve, would you want to use a rising stem gate valve? --- probably not because the stem might hit the top of the box well before you had the valve completely opened. Right?

Looking at it from a different point of view the rising stem gate valve is better than the non rising stem in some cases because from a distance you can tell whether it is opened or closed by looking to see whether the stem is up or down.

Well now you know the basics of the rising and non rising stem gate valves. One more thing: Never open or close these valves part way. They must be fully opened or fully closed or the disks will be damaged and worn away by the fuel passing through.

NOTE: More information on these valves is contained in FM 10-20, Chapter 3, page 17.

Globe Valves

This is valve # 3. It is just like the valve on your kitchen and bathroom faucets. This is the only valve that you will ever use to "throttle" or regulate the flow of fuel. You can let fuel trickle through, go through "full-blast" or any amount in between.

As you can see, this valve has a handwheel. As a matter of fact it works almost just like the non rising stem gate valves you just learned about. The major difference is that this valve has only one horizontal disk. Stop now and refer to FM 10-20 page 19 figure 16.

See what we mean by "horizontal disk"? This type of valve is used in and around tank farms but they are not used in the actual pipeline system because they will not permit scrapers to pass through the line (We will discuss scrapers later in the course). Page 17 of FM 10-20 contains a little more information on globe valves - read it now.

Plug Valves

Look at the valves in the "manifold" display. Instead of a handwheel, these valves have a removable plug wrench. By placing the plug wrench on the valve stem nut - see the display - the valve can be fully opened or closed with a quarter turn of the plug. Try opening or closing the valve now by turning the plug wrench. See how fast you can open or close it? This valve is not to be used for throttling the flow of fuel. See page 17 and 19 now for more information on plug valves.

Check Valves

Look at valve # 4. This is a check valve. It automatically keeps fuel flowing in only one direction (shown by arrow on the top of the valve). If you have one of these valves at the bottom of a hill and your pump stops, the fuel in the line cannot flow back down. Why? Because there is a hinged disk or clapper inside the valve which is pushed out of the way when the product is flowing in the desired direction. When product tries to flow in the reverse direction, this disk swings back and closes off product flow.

Look at the valve on display and find this disk or clapper. Flip it and see what we mean.

Read the information and look at the pictures in FM 10-20 on the check valve.

Now read the information contained in paragraph 29 on pages 19 and 20 in FM 10-20. This paragraph deals with valve inspection and maintenance. After you have finished reading the FM and feel that you know the information it and this program contains, do the Practical Exercise on the next page.

Practical Exercise I

1. Which type of valve is used to throttle product flow?

____

2. Which type of valve requires periodic packing with graphite spiral or ring packing? ______________________________

3. Circle the valve or valves which have a handwheel.

   A. Rising stem gate valve.

   B. Non rising stem gate valve.

   C. Plug valve.

   D. Check valve.

   E. Globe valve.

4. Which one of the gate valves can you tell at a distance is opened or closed? ______________________________

5. How far must a plug valve be turned to fully open or close it?

   A. 1 turn

   B. ¼ turn

   C. ½ turn

   D. 2 turns

6. What type of valve is used primarily in a pipeline system?

____

7. What type of valve is located in tank farm manifolds and used as a positive shut off valve? _________________________________

8. What type of valve is commonly found on the discharge side of pump units and used to prevent reverse product flow? ______________________

NOTE: Answers to the above questions are on the next page.

If you had trouble answering these questions or couldn't, review this program and the information contained in FM 10-20, Chapter 3, until you feel you really know the material.

When you feel you know all the material, review the lubricating procedures on page 20 of FM 10-20 then tell your instructor you are ready for the performance exercise.

PS-D-5-PFS

QMS 300.502

Practical Excercise II

The performance exercise will include lubrication and/or repacking of valves in the Petroleum Training Area.

614

PS-D-5-PFS

QME 300.502

Answers To Practical Exercise I

1. Globe Valve
2. Gate Valves
3. (A) (B) (E)
4. Rising Stem Gate Valve
5. B - ¼ turn
6. Gate Valves
7. Globe Valve
8. Check Valve

623

PART 3

PIPES

By now you have heard about the pipeline at least a "thousand times"!! Also, you've seen the pipeline and related facilities just about every time you went to the Petroleum Training Area. Right? Well, this portion of the program will teach you a few basics about the acutal types of pipes used in a Petroleum Pipeline.

There are 2 major types of pipe used in [illegible]troleum Pipeline:

1. Lightweight Tybing: Look at the displayed sample. See the thickness of the pipe wall? This pipe is used in military combat pipelines (temporary). It's relatively light weight and since it comes in standard 20 foot lengths it's fairly easy to handle. This pipe is commonly joined - one section to another - by using a grooved coupling. See the coupling on the display - it is called a split ring groove-type coupling (See figure 1 in this program). As you can see from the figure there is a rubber gasket placed over the joint between the 2 pipe sections then the housing is bolted on. About the only thing that you have to do in the way of maintenance on this type of coupled pipeline is to look for leakes and:

a. Righten the "oval neck Track Bolt. (See Fig. 1) If this doesn't stop the leak you have to:

b. Replace the "self sealing gasket". (See Fig. 1)

One last thing: See the weld (seam) running down the pipe lengthwise? Whenever you see this on petroleum pipe you know it's lightweight tubing.

NOTE: This pipe is available in 4", 6", 8", and 12" diameters.

2. API or commercial type pipe: Look at the display board and find "API" pipe. This pipe is built to American Petroleum Institute standards. API pipe is much more sturdy than Lightweight Tubing and is therefore used in permanent or fixed facilities where "long life" is required. Look at the display, see the thick walls on this pipe? It's much thicker than the lightweight tubing. Right? Well that's why combat pipelines aren't made of API pipe: it's too heavy and hard to handle in a hurry.

616

Also, since this type of pipe is generally "permanently installed", the pipe sections are usually welded together instead of "coupled" using split ring groove-type couplings. They can be grooved though.

Note: This pipe is available in 4", 6", 8", 12", or larger diameters.

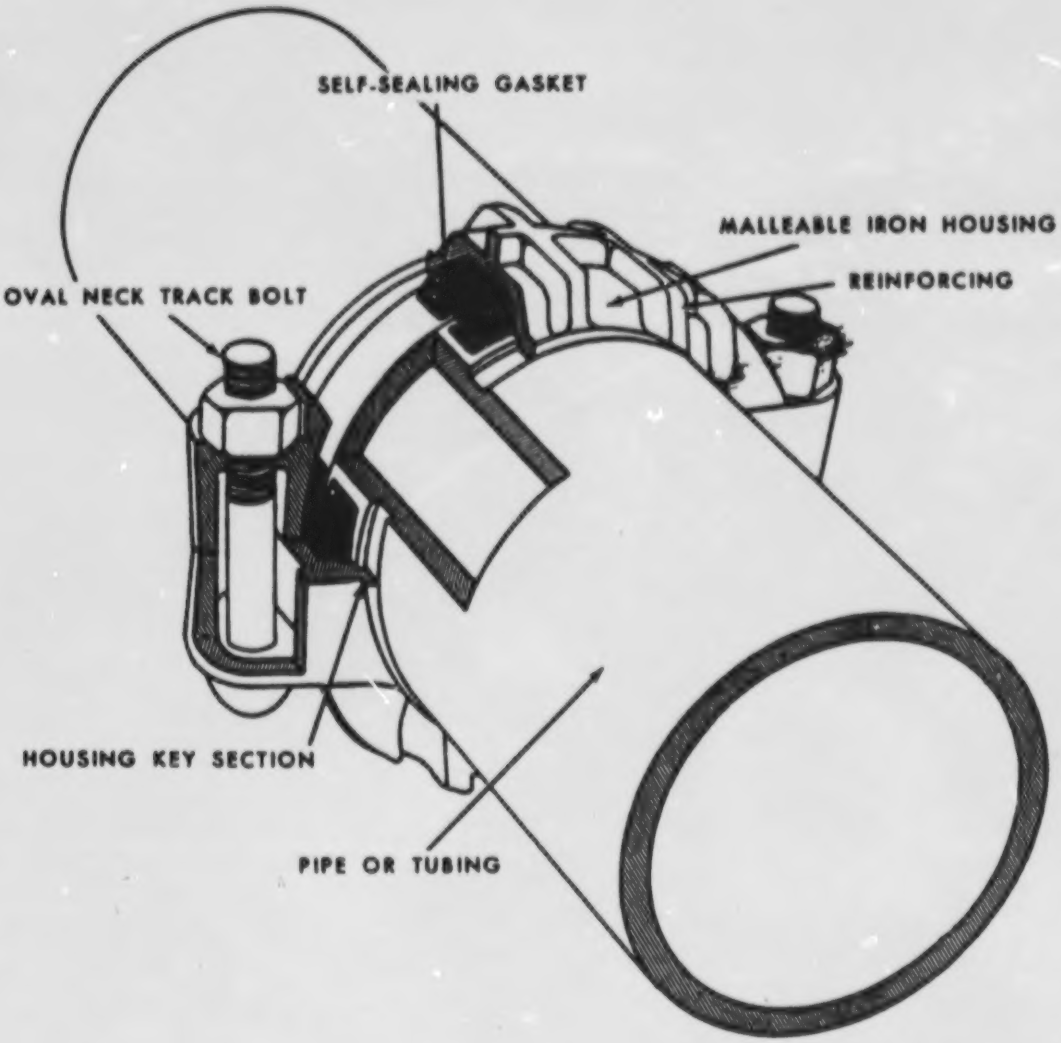

SELF-SEALING GASKET
MALLEABLE IRON HOUSING
REINFORCING
OVAL NECK TRACK BOLT
HOUSING KEY SECTION
PIPE OR TUBING

Figure 1

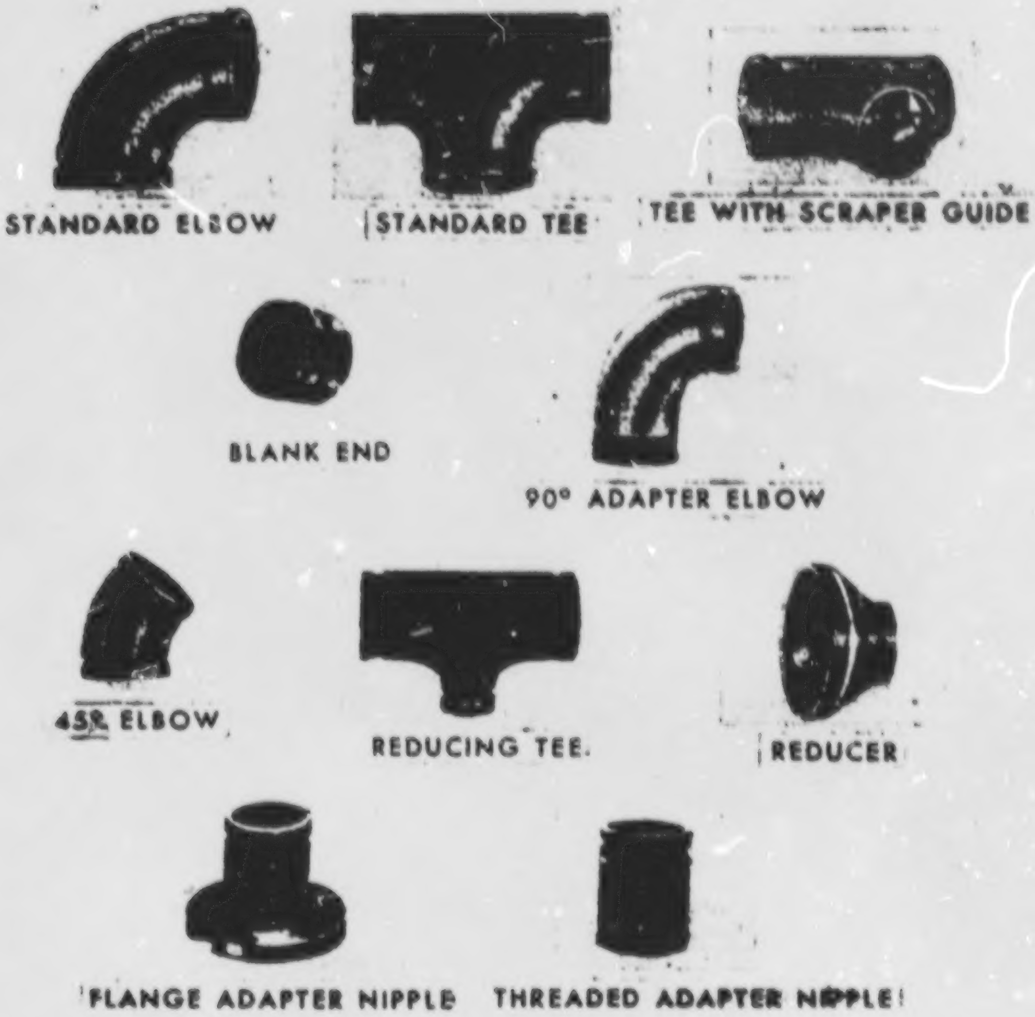
PART 4

FITTINGS

So far we have discussed straight pipe sections. What happens if we want to make a bend or build a manifold?

Anytime there is a need to make a bend or build a manifold, Fittings are used. Standard groove-type fittings include elbows, tees, reducers, blank ends, and adapters. Some of these fittings are shown in figure 2. Take a good look at the fittings in figure 2 then look at the real thing on display. Learn the names of these fittings - you are a professional petroleum man and you must know the language of your profession.

When you feel you know the information contained in this program, notify your instructor for further instructions.


STANDARD ELBOW
STANDARD TEE
TEE WITH SCRAPER GUIDE
BLANK END
90° ADAPTER ELBOW
45° ELBOW
REDUCING TEE.
REDUCER
FLANGE ADAPTER NIPPLE
THREADED ADAPTER NIPPLE

Fittings for groove type pipe.

Figure 2

620

QMS 300.507 H-1

MANIFOLDS

HANDOUT

PROPONENT DEPARTMENT: Petroleum and Field Services

November 1976

THIS SUPERSEDES: QMS 300.507 H-1 DATED MAY 1974.

621

MANIFOLDS

OBJECTIVE: As a result of this instruction and when provided with a bulk petroleum facility equipped with a manifold, the student will be able to identify the purposes of manifolds used in bulk petroleum operations, identify pipelines by standard marking codes, and operate the manifold.

REASON: Tank terminals, the place where large quantities of "bulk fuel" are stored, as a rule are designed and constructed to accommodate more than one type petroleum product. Once a tank is filled, however, that tank is usually kept in single product service. The pipelines which carry product away from the tanks are generally designed to carry all the various products from the numerous tanks in the terminal. How do we get the product from any of these tanks into a multi-product pipeline without confusion and without commingling the product beyond usefulness? The answer is by using a manifold. You will learn all a 76W10 has to know about manifolds by using this program.

PROCEDURE: This is a self-paced program. In order to successfully complete this program you must follow each and every direction given - TO THE LETTER. Don't skip ahead and don't hesitate to call on your instructor if you need help or don't understand something.

The first part of this program will deal with product flow into, out of, and through a manifold system. The second part of this program will teach you how to mark and recognize pipeline markings. By looking at these markings you'll be able to tell at a glance just what type of product that line contains or is used to handle. The last part of the program will take you to the Petroleum Training Facility where you will actually operate a pipeline manifold.

Any questions? Let's begin.

630

PART 1

Go to the study area in Bldg 11400. Remember the manifolds you worked with on Tank Vehicles? Well, the manifolds you'll learn today are basically used to do the same thing - direct the flow of one or more products to wherever you want them to go. Its just a little larger and controls the flow of a lot more fuel.

Lets take a look at a simple two tank manifold. Pull Figure 1 out of your program and look at it. Assume that all valves in the manifold (1, 2, 3, 4, and 5) are closed. Try to trace the flow of fuel from Tank #1 through the manifold to the transfer pump and out of the Terminal to the outgoing pipeline. Write the numbers of the valves you must open down here ______________________________.

You should have opened valve number 1 and valve number 4. Look at Figure 2 and see the fuel flow (dotted line). Got it?

Now try to take fuel out of Tank #2 and pump it to the "outgoing pipeline." What valves would you open? ______________________

You should have opened valve number 3 and valve number 4. Look at Figure 3 and see the fuel flow (dotted line).

Well, now you know how to use a manifold in order to take fuel out of a tank and pump it out into the pipeline. If you don't understand what's happening, review what we have just talked about and ask your instructor for a hand. If you do understand everything we've talked about so far, read on and see how to use the manifold to transfer product from one tank to another.

Look at Figure 1 again and write down the valves you open to move product from Tank #1 to Tank #2. ______________________

You should have opened valves numbered 1, 4 and 5 - Look at Figure 4 for the flow of product. (Dotted Line.)

If you opened the correct valves, try receiving product off the pipeline, move it through the pump and manifold and put it into Tank #2. What valves would you open? ______________________

Look at Figure 5 for the "dotted" line of product flow. You see that it goes through valve number 1 through the pump then through vavles number 4 and number 5 and into Tank #2.

If you didn't open these valves and only these valves, review what we've just talked about or ask an instructor for help. After you feel that you know all the information we've discussed, try making up a few pumping situations to test yourself.

623

Take out the large handout titled, "Tank Farm #1 Manifold." As you can see, there are 10 storage tanks. The manifold is exactly the same as the one shown in Figure 1 that you just worked with except it's larger. Take out your pencil and trace along on the large handout as we follow the flow of fuel out of Tank #9, through the manifold, transfer pump and into the outgoing pipeline. Put your pencil on Tank #9. Draw a line out of Tank #9 down the service line through valves numbered 90 and 91. Keep in mind that we want to get to the suction side of a transfer pump. Which valve will we open to get there? Take a few seconds and see. Valve number 93 will get our product into the suction side of pump #1, right? OK, continue drawing your line going through valve number 93 and down the line to the pump. Go through valve number 300 into the pump and out valve number 301 on the discharge side. Now we want to get into the outgoing line. What valve will we open to get there? Look and see! As you can see, if you open valve number 500 you are into the outgoing pipeline. Draw a line down through valve number 500 and go to the right out through valve number 504 and down the outgoing pipeline.

Let's review what we just did. We took fuel out of Tank #9 and into the outgoing pipeline. Here are the valves we opened starting at the Tank: 90, 91, 93, 300, 301, 500, and 504.

If you didn't draw your line to trace product flow, do it now!

Study the diagram until you think you know how to take fuel out of any tank farm and pump it out the outgoing pipeline.

Think you've got it? OK, use your pencil if you think it helps and trace the flow of fuel out of Tank #8, through the manifold and transfer pump #1, and into the outgoing pipeline. Write the valve numbers that you would open to perform this operation. Then check below to see if you were correct.

These are the valves you should have opened starting from Tank #8: 80, 71, 73, 300, 301, 500 and 504. What are the settings you would make if you used transfer pump #2?

You Should have opend valves number 80, 71, 75, 302, 303, 502 and 504.

Think you know how to take fuel out of a tank and pump it out the outgoing pipeline? Try a few situations on your own.

Here's an example of how you would transfer fuel from one tank to another within the tank farm. We're going to transfer fuel from Tank #1 to Tank #3 using transfer pump #2.

The following valves will be opened starting from Tank #1: Valve 10, 11, 15, 302, 303, 36, 31, 30, to Tank #3. Trace the flow of fuel through these valves if you haven't already. Then try the following:

632

Transfer product from Tank #5 to Tank #7 by using transfer pump #1.

If you didn't open the following valves starting at Tank #5, go back and review this portion of the program. Valve 50, 51, 53, 300, 301, 74, 71, and 70.

Don't go any further in this program if you don't understand what's been discussed up to this point. Review the portions of the program you don't understand or ask your instructor for help.

If you do know what's going on we have one more thing to learn on the operation of a pipeline manifold, then we'll go outside and see if you can operate the real thing.

This exercise will deal with taking fuel from the incoming pipeline and putting it into a tank in the farm. Remember, the fuel coming in off the pipeline is under pressure and can get to the tanks all by itself. You don't have to use the transfer pump. All you have to do is open the correct valves and let the fuel flow!!!

Try taking fuel from the incomeing pipeline and put it in Tank #10. Remember, you don't have to use the transfer pump. In order to get the fuel into Tank #10 you should have opened valve 507, 503, 501, 107, 101, and 100. Trace the flow and see what we mean. Try a few more situations for yourself. See if you can operate the manifold in a multi-product situation. Try receiving or issuing multiple fuels from the pipeline. Then, when you feel you know how to operate a manifold, try the following exercise.

PRACTICAL EXERCISE

1. Using transfer pump #2, pump fuel out of Tank #1 out the outgoing pipeline. List the valves you would open starting at Tank #2.

____

To find out if you're right, check the solution on the following page.

2. Try transferring fuel from Tank #9 to Tank #4 using transfer pump #1. List the valves you would open starting at Tank #9.

____

Check the following page for the correct answer.

3. Take fuel from the incoming pipeline and put it in Tank #3.

   a. Do you have to use a transfer pump? ____________________

   b. List the valves you would open starting at valve number 501.

____

Check your answers on the following page.

SOLUTION #1

You should have opened the following valves: Tank #1, Valves 10, 11, 15, 302, 303, 502, and 504.

SOLUTION #2

You should have opened the following valves: Tank #9, valves 90, 91, 93, 300, 301, 44, 41, 40, and Tank #4.

SOLUTION #3

a. No. You don't have to use a transfer pump, because the fuel comes off the pipeline with enough pressure to move through the manifold and into the receiving tank.

b. You should have opened the following valves: 501, 37, 31, and 30.

If you had any problems with the above exercise, go back and review the program materials or ask an instructor. If you didn't have any problems, go on to Part 2 of this program.

627

PART 2

Go to the pipeline display area. Take a look at the manifold set-up on the left. Now you see that the manifold valves we've been opening "on paper" are really plug valves. See the wrench? As you recall, the valve is opened and closed by turning the valve stem with the wrench. How can you tell that the valve is open or closed? Look at the valve stem, see the white arrow or tab? When this tab or arrow (depending on who manufactured the valve) points to the direction fuel would take in moving through the valve, the valve is open. When the arrow or tab points across the valve, the valve is closed. Try opening and closing the valve and see what we mean.

Now find yourself a seat in front of the pipe section with all the yellow stripes and lettering painted on them. These stripes and product names weren't just painted on the pipes because the Quartermaster School thought it would look nice that way. This is a marking system that the Defense Department says must be used to identify liquid petroleum pipeline systems. The stripes are painted around the pipe so that even if you are too far away to read the product name, you can still tell what product the line is used for -- if you know the marking code!

Here is how we mark petroleum pipelines:

Aviation gasolines - 1 yellow band

Automotive gasolines - 2 yellow bands

Jet fuels - 3 yellow bands

Diesel fuels - 4 yellow bands

Multi-product lines - 1 wide band

In addition to the yellow bands, the product name is printed in white on a black background. Look at the display and see how the pipes are marked.

Railcars and storage tanks and tank trucks use the same type of marking system only the stripes don't go all the way around (encircle) them. The exact width of the bands and height of the lettering is contained in Military Standard 161D.

The important thing for you to remember is the number of stripes you see on a pipe, railcar, storage tank, or tank truck and what product they identify. Learn them because you will be tested on how well you can identify a product by looking at the marking code. When you think you know "pipeline identification", try the following exercise.

636

1. If you saw a pipeline from a long distance away and couldn't read the painting but could see 2 yellow stripes, what petroleum product does that line contain?

____

2. How many stripes would you paint on a bulk storage tank to indicate aviation gasoline?

____

3. A single wide yellow stripe on a pipe signifies what?

____

4. Is the painted portion of the marking code: (underline answer)

   a - white letters on a black background?

   b - black letters on a white background?

5. How would you mark a pipeline that contains diesel fuel (how many stripes)?

____

SOLUTION

The answers to the questions on the preceeding page are:

1. Automotive gasoline.
2. One (1) yellow stripe.
3. Multi-product pipeline use.
4. a - white letters on a black background.
5. Four (4) yellow stripes.

If your answers didn't match the solutions, go back and study part 2 of this program or ask your instructor for help.

When you feel that you know pipeline marking, go on to part 3 of this program.

PART 3

In this part of the program you will actually operate a pipeline manifold. Go to the Depot manifold in the Petroleum Training Area.

Take a few minutes and look the Depot over. Stand at the pump and look toward the Railcar. See the pipes to your left leading away from the Depot? The pipes furthest away from you lead to other terminals and eventually out onto the pipeline.

This Depot has many functions but the most important is to load and off-load railcars. This part of the program will teach you how to transfer fuel between Tank #11 and #12. Also you will learn how to load and off-load the railcar, pump out of Depot to a pipeline terminal and receive fuel from a pipeline terminal.

Ready? Lets get on with it!

OPERATION #1

Transfer fuel from Tank #11 to Tank #12 using pump #10. In this operation you will be told which valves must be opened. The you will be given a practice exercise to see how well you can perform a similiar operation with no help.

NOTE: Check all valves at this time and make sure they are all CLOSED.

The best way to trace the flow of fuel in this operation is to walk along the same path the fuel will follow. Go to Tank #11 and stand beside the tank service line (line going into Tank #11 that takes product into and out of tank). Open the rising stem gate valve marked number 11-1. The fuel is now stopped by valve number 11-3. Open valve number 11-3 and the fuel flows to the suction side of pump #10. Open the green suction valve and the red discharge valve (don't open the red discharge valve at this time). Now the fuel is into the manifold. The task before you is to open only those valves which will permit fuel to flow thorugh the manifold and into tank #12. Take a minute and see if you can determine which valves need to be opened to put fuel into the line going to Tank #12. Easy right? You should see that if you open plug valve #12-8 fuel will flow into Tank #12's service line. Trace the flow of fuel from the pump, through valve number 12-8 and into the Tank #12 service line. Now walk down the service line toward Tank #12. Open rising stem gate valves number 12-2 and 12-1 and the fuel will flow into Tank #12.

Lets review what we have just done. We set-up the manifold to transfer fuel from Tank #11 to Tank #12 using transfer pump #10. Here is a list of all the valves that were opened to perform this operation starting from Tank #11: #11-1, #11-3, pump suction valve, pump discharge valve, plug valve #12-8, gate valves numbered 12-2 and 12-1.

Review this operation until you think you have it down pat. Don't go on to the next operation until you are sure of yourself. When you feel you know how to transfer fuel from tank to tank at Depot, move on to practical exercise #1.

NOTE: CLOSE all valves at this time!

PRACTICAL EXERCISE #1

In this operation you will be required to transfer product from Tank #12 to Tank #11 using transfer pump #11. Take your time and make sure you open the correct valves. You don't have to actually open any valves, just write them down in the space below starting at Tank #12. When you have written down the valves you think must be opened to perform this operation, take the list to your instructor and he'll tell you whether or not you are correct. Don't have him check your list unless you feel sure of your valve choices.

List of valves to be opened starting from Tank #12: ____________________

____.

If your choice of valves was correct go on to Operation #2. If not, review operation #1 and try practical exercise #1 again. Don't go on to operation #2 unless you understand operation #1 completely.

OPERATION #2

This operation will deal with the Rail Tank Car. We will take fuel out of Tank #11, through the manifold and pump it into the top of the rail car using transfer pump #9.

NOTE: Rail tank cars can be filled through the top by using the overhead fill stand or through the bottom. ---More about this when you get to the Rail Tank Car program.

Look over the Depot manifold and try to get a feel for what we are going to do, then go to Tank #11. Out task is to get fuel from Tank #11 into the suction side of pump #9. We can do this by opening valve number 11-1 (open it!), now open 11-5. Follow the line into the manifold area and you see that the fuel flows freely from valve 11-5 to the green suction valve on pump #9. Open the suction valve and the red discharge valve (don't open the red discharge valve - just pretend). Now we have fuel in the manifold. Open plug valves D-9, D-5, and P-2 (trace the fuel flow). The fuel is now on its way to the rail tank car through the line marked "Rail Car - Overhead". Go back and review what you just did. Here is a list of the valves you opened starting at Tank #11: valve 11-1, 11-5, green suction valves on pump #9, red discharge valve, D-9, D-5 and P-2.

Trace the flow of fuel from Tank #11 to the rail tank car. When you feel you know this operation go on to practical exercise #2. Don't go on unless you understand what you're doing!

CLOSE all valves at this time!

PRACTICAL EXERCISE #2

Move product from the rail tank car to tank #12 using transfer pump #10. Write down the valves you would open starting at gate valve number R-4 (between the rail car and depot manifold). List of valves to be opened starting at the rail tank car: ______________________________ ____.

When you feel that the valves on your list will get the job done, show it to your instructor to find out if you're right. If you are, go on to Operation #3. If you didn't pick the correct valves, review Operation #2 and do Practical Exercise #2 again. Don't go on to Operation #3 until you know what's happening.

NOTE: Close all valves at this time.

OPERATION #3

In this part of your program you will receive product from a terminal--under pressure--and put it in Tank #12. Remember, the product is coming into the depot under its own pressure so you don't have to use a transfer pump to pump it into Tank #12. Just open the correct valves and it will flow into the tank all by itself.

Stand at a pump facing toward the rail car. See the pipes leaving the manifold to your left? Go the pipe marked "L - Line". Walk along the pipe away from the manifold till you come to valve number L-5. When this valve is opened fuel will fill the line and move toward the manifold. Here are the valves that must be opened to make the product flow into Tank #12. Starting at valve number L-5: 12-8, 12-2 and 12-1. Trace the flow of fuel through the valves and review this operation until you know it. When you have it all together, go on to Practical Exercise #3.

NOTE: Close all valves at this time.

PRACTICAL EXERCISE #3

In this exercise you will be required to take product out of Tank #11 and pump it out the "L-Line" using pump #10. Write down the valves you would open to perform this operation starting at Tank #11: ____________ ____.

When you feel confident that you have made the correct valve choices, check with your instructor and find out what he says. If you have made the correct choices, you have completed this program and are ready to go on to the next program in the course. If you haven't made the correct choices on which valves should be open for this operation, review operation, review operation #3 and then try practical exercise #3 again.

REMEMBER: Before you operate a manifold and after you operate one, CLOSE ALL VALVES. This prevents fuel flow in a direction you might not want it to go in. By closing all valves and then opening only those you want to, you can be positive of the direction fuel will flow through the manfold.

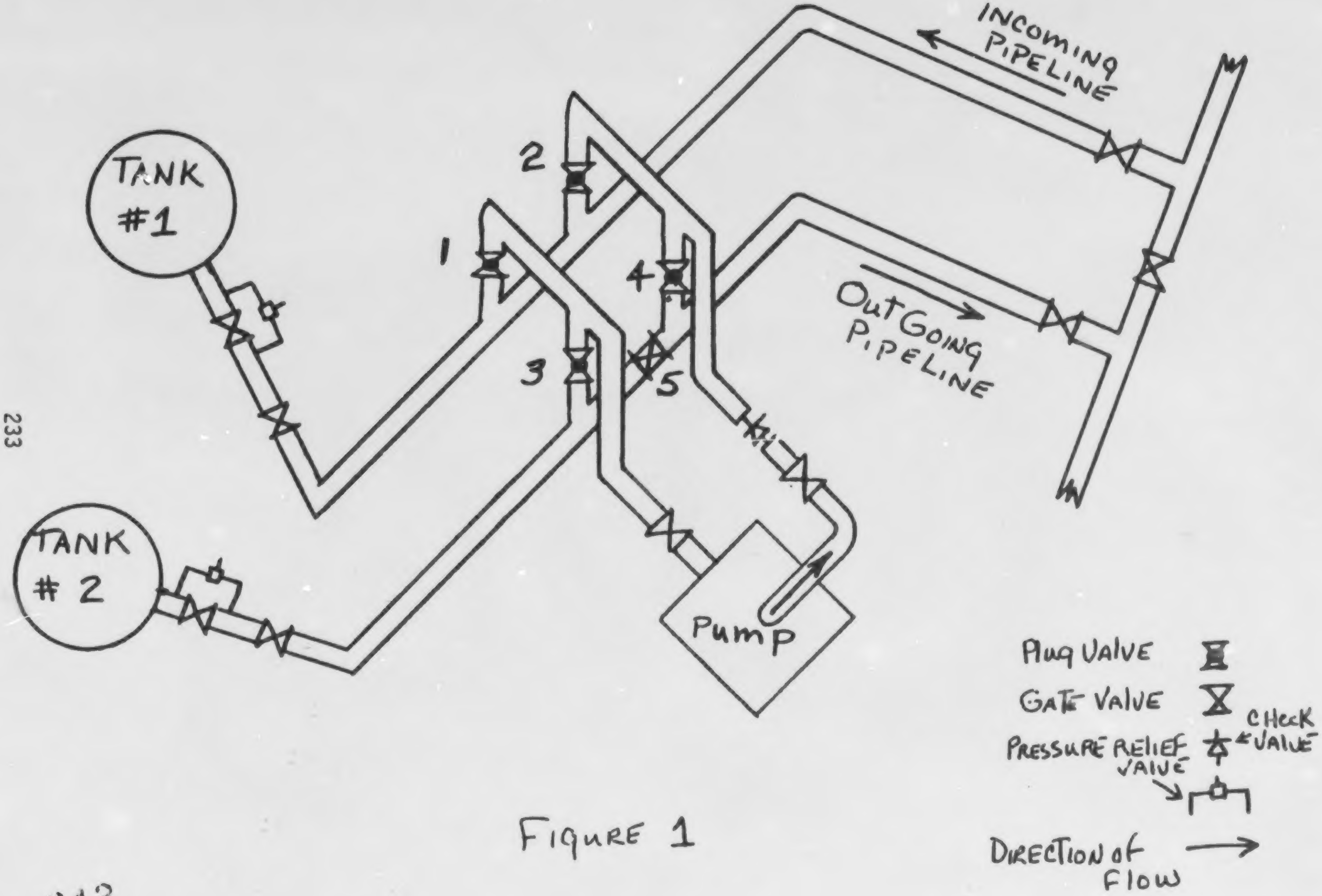

INCOMING PIPELINE
TANK #1
2
1
4
3
5
OutGoing PIPELINE
TANK # 2
Pump
Plug Valve
Gate Valve
CHeck Valve
PRESSURE RELIEF VALVE
DIRECTION of FLOW

Figure 1

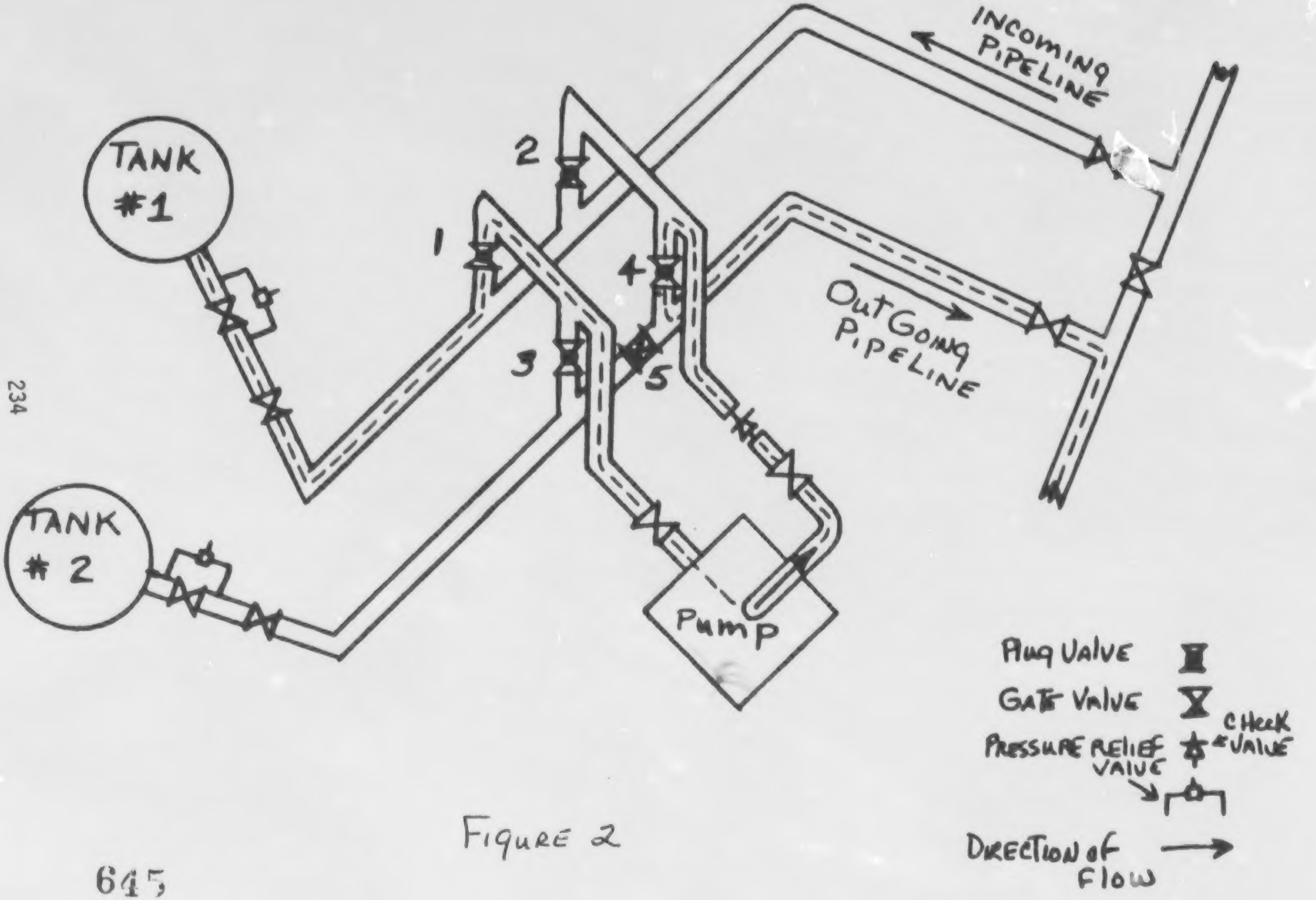

TANK #1
TANK # 2
1
2
3
4
5
INCOMING PIPELINE
OutGoing PipeLine
Pump
Plug Valve
Gate Valve
Check Valve
Pressure Relief Valve
Direction of Flow

Figure 2

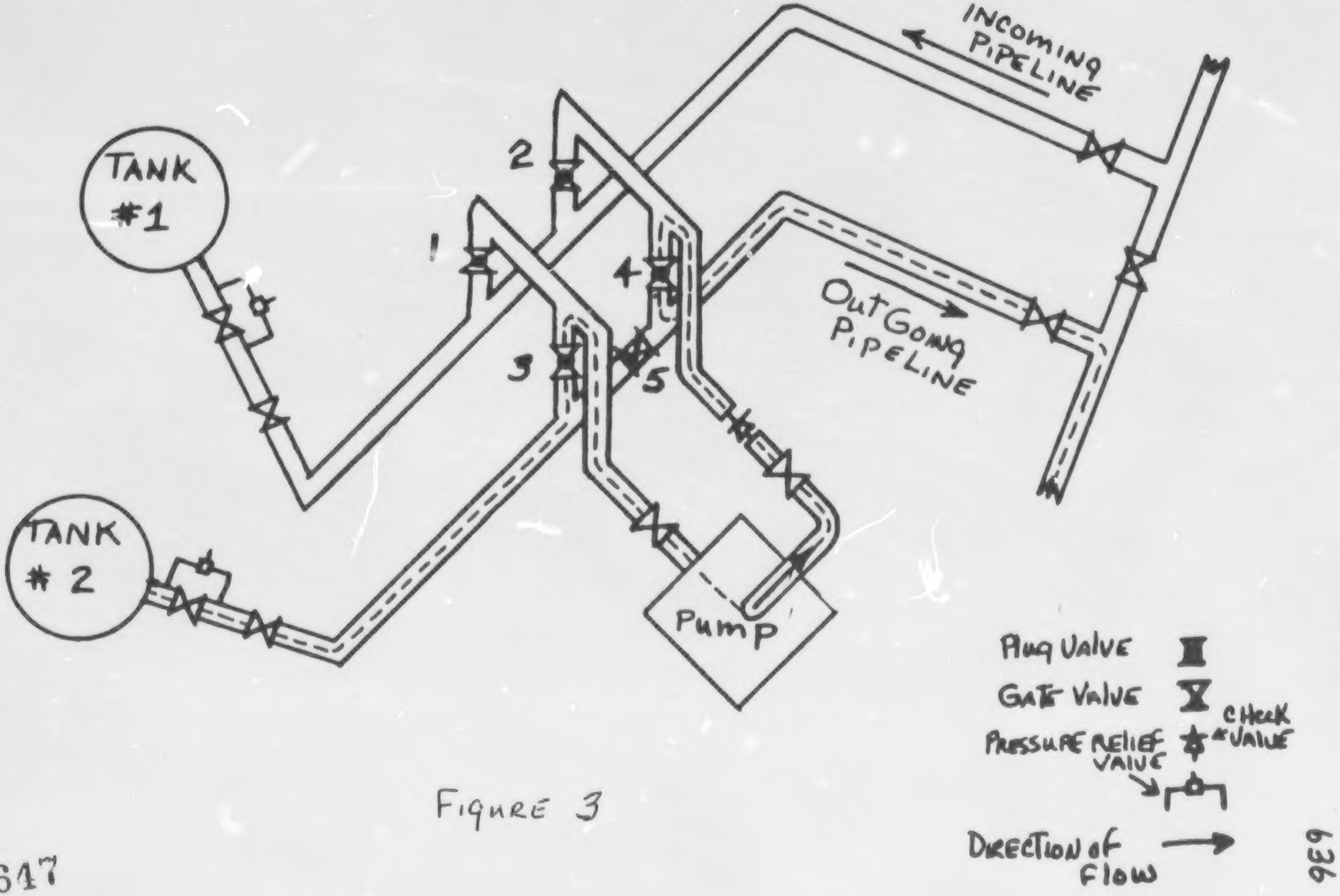

INCOMING PIPELINE
TANK #1
2
1
4
3
5
OutGoing PipeLine
TANK # 2
Pump
Plug Valve
Gate Valve
Check Valve
Pressure Relief Valve
Direction of Flow

Figure 3

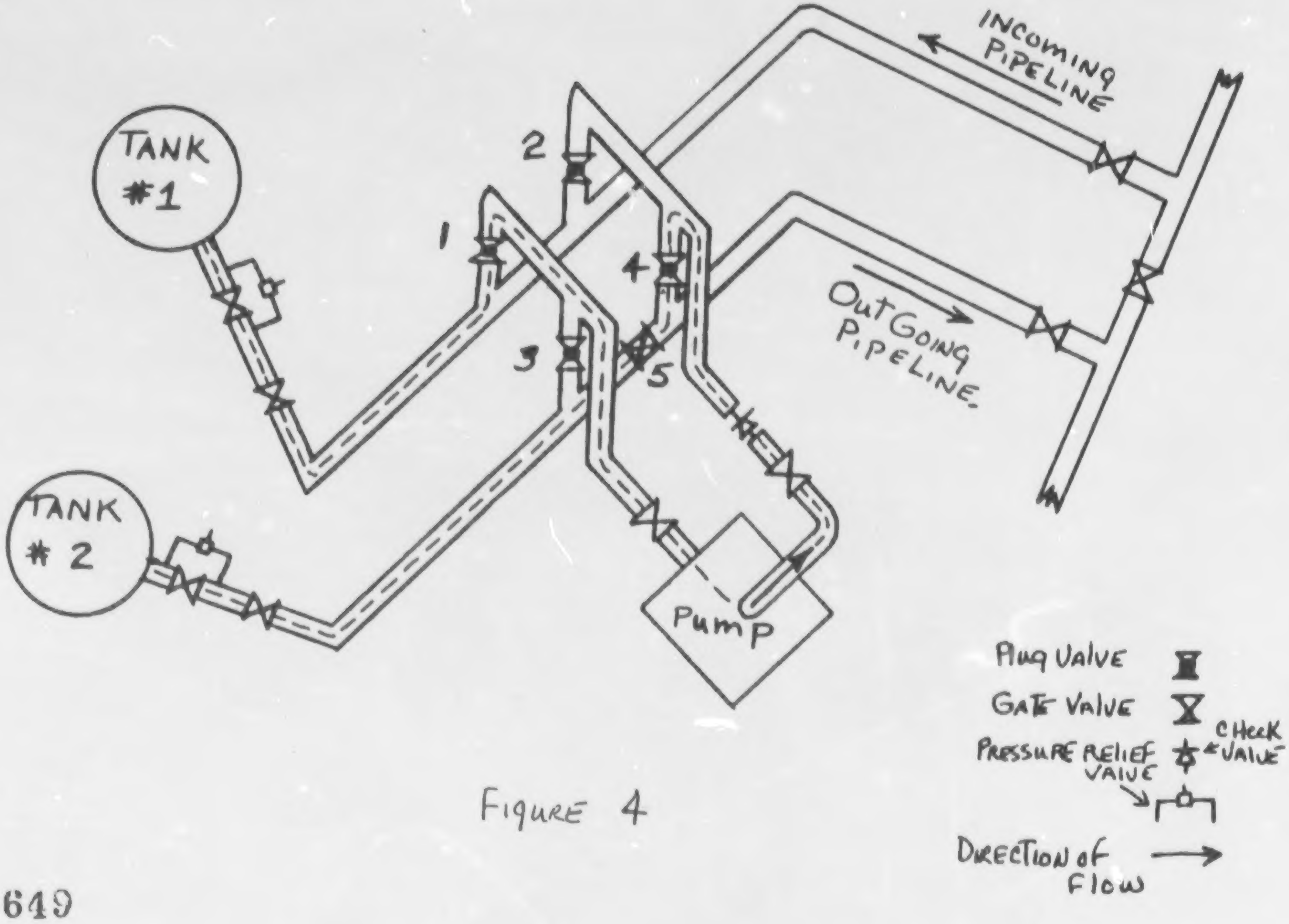

TANK #1
TANK # 2
1
2
3
4
5
INCOMING PIPELINE
OUT GOING PIPELINE.
Pump
Plug Valve
GATE Valve
PRESSURE RELIEF VALVE
CHECK VALVE
DIRECTION of Flow

Figure 4

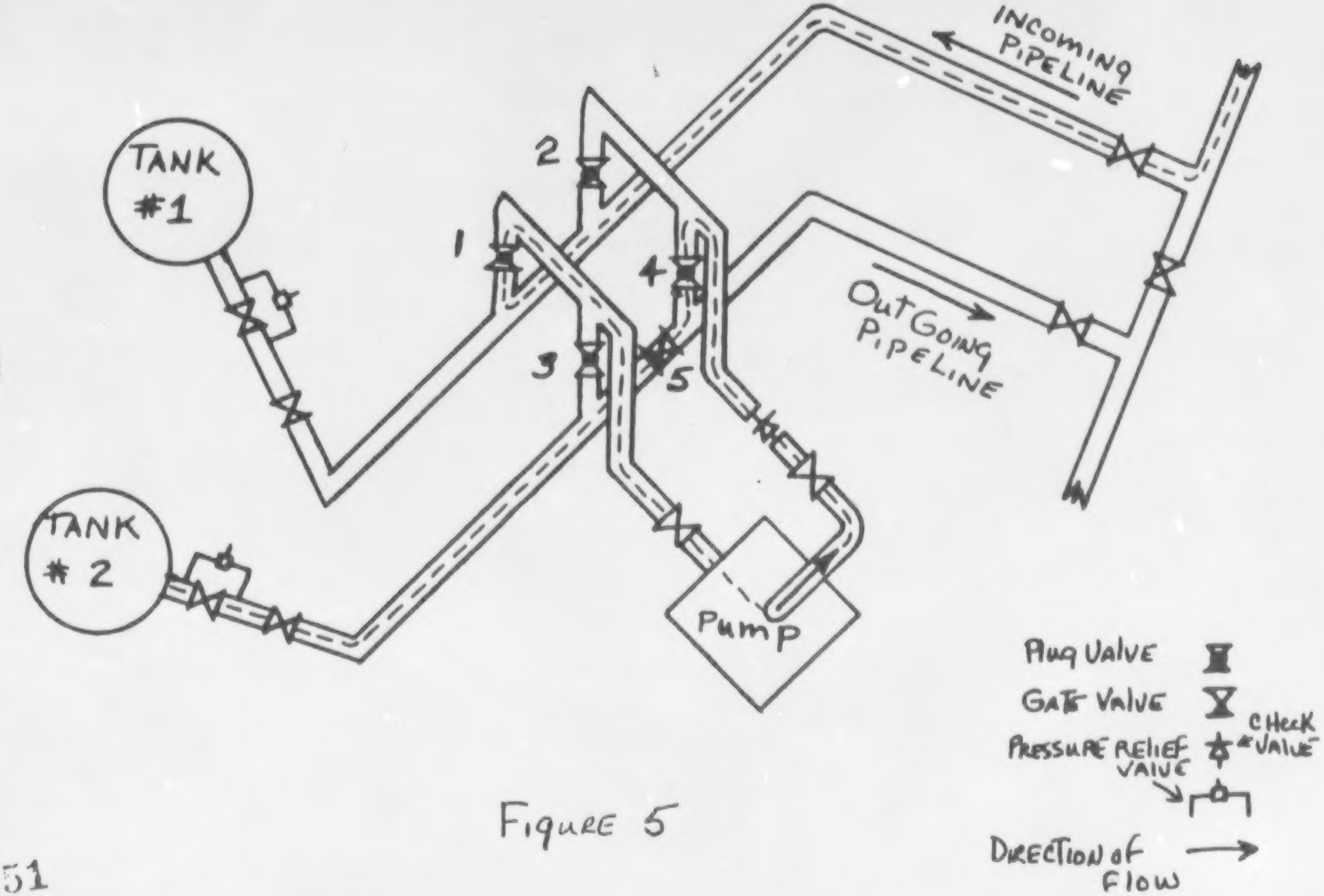

INCOMING PIPELINE
TANK #1
TANK # 2
1
2
3
4
5
OutGoing PIPELINE
Pump
Plug Valve
Gate Valve
Check Valve
Pressure Relief Valve
Direction of Flow

Figure 5

639

QMS 300.508 PT
PS-D7-PFS

SIX INCH TRANSFER PUMP

PROPONENT DEPARTMENT - Petrl & Fld Svcs Dept

NOV 76

653

INTRODUCTION

In almost every POL terminal the U.S. Army has you will find the Six-Inch Single Stage Pump. Sometimes it is referred to as a "Transfer Pump" or a "Feeder Pump." Whatever you call it, you can be sure as a Petroleum Supply Specialist you will be operating this pump.

During this block of instruction you will learn how to perform operators maintenance and how to operate this pump. Read your instructions carefully and follow your directions closely.

Before you turn the page and begin you should go to the study area for this pump in Bldg. 11400.

OBJECTIVE

As a result of this instruction and when provided with a six-inch, single-stage pump unit and facilities, the student will be able to perform operator maintenance and fill out DA Form 2404 on a single-stage pump unit, operate the pump unit in accordance with given situations, and perform all safety precaution checks.

PART ONE

In this part you will learn some general information about this pump. Read carefully the information that follows.

The pump is normally found at terminals, tank farms, and most places where bulk fuel is transferred. It is used in truck and rail car loading, bulk reduction stations and tank farm complexes as a transfer pump. It is also used as a feeder pump to pump fuel to pipeline pump stations.

The proper name of this unit is "Pump, Centrifugal, Gasoline Driven, Skid Mounted, 6 - Inch, 1120 GPM, Self-Priming". From the name you can see the pump is rated to pump 1120 gallons per minute. The whole unit is skid mounted with a shipping weight of 3400 pounds.

The engine is a 6 cylinder, gasoline powered, water cooled engine, and develops 60.4 horsepower. The gas tank holds 13 gallons when full. The crankcase holds 8 quarts of oil with a filter. The normal operating speed is 1800 RPM. The idle (warm up) speed to 400 to 600 RPM.

For detailed information you can refer to TM 5-4320-233-15.

ANSWER THE FOLLOWING QUESTIONS

1. How is the pump primed?

   ____

2. What is the warm up speed of the engine?

   ____

3. At 1800 RPM what is the gallons per minute rating of the pump?

   ____

4. What kind of fuel is used in the engine?

   ____

5. How is the engine cooled?

   ____

6. What is the horsepower of the engine?

   ____

7. Where would you normally find this pump?

   ____

8. What is the pump used for?

   ____

ANSWERS TO QUESTIONS ON PAGE #3

1. It is self-priming.
2. 400 to 600 RPM
3. 1120 GPM
4. Gasoline
5. It is water cooled using a radiator.
6. 60,4
7. The pump is found is use wherever bulk fuel is handled in the Army.
8. The pump is used as a transfer pump in terminal operations and as a feeder pump in pipeline operations.

If your answers don't agree re-read Page #2. If you have a question feel free to ask your instructor for help.

PART TWO

In this part you will take a close look at the various parts, controls, and instruments on the pump and engine. As each part is discussed, locate it on the engine in front of you so you will know exactly where everything is and how it works. If you should have a problem, see your instructor.

Stenciled on the pumping assembly are numbers (1) through (4). These numbers are on this pump to help you locate the items discussed.

1. On the front of the pump you see number (1). This is the suction port of the pump.

2. Number (2) is the discharge port. Just above the number (2) is an air eliminator valve. This is a manually operated valve and during warm up you open this valve just long enough to eliminate air from the pump.

3. Just below the discharge port and on the pump body you see a square plug. This plug is the priming port for this pump. Even though this pump is a self primer, there are times when it must be primed. For example a newly installed pump must be primed before the engine is started.

4. On the other side of the pump you will find a similar plug. This plug is a drain plug for the upper pump case. In some pipeline operations you may find a line tap in this port for drawing off samples or for refueling the pump station fuel supply.

5. Below the suction port and near the bottom of the pump you will find another square plug. This plug is the drain plug. In cold weather this plug is used to drain the pump when water is suspected in the pump.

6. Find the number (3) on the back side of the pump. This number is on the oil reservoir for the pump main bearing. Always make sure this cup has oil in it before you start the pump and during operations check it frequently to make sure there is always oil in this cup.

7. Go to the discharge side of the pump and locate mumber (4). Number (4) is on the pump drive shaft housing. Just below number (4) is a sight glass. Never operate the pump unless the sight glass is at least half full of oil. When it gets low on oil remove the small plug on top of the shaft housing and pour oil in that hole until the sight glass is one half to three quarters full. Never fill it full.

8. Numbers (5) through (12) are on the engine components of this unit. Locate number (5). Number (5) is on the gas cap and this is where fuel is added. Use only automotive gasoline. Never fill the tank completely full. After operations fill the tank to 3/4 full. The tank gage is just to the right of the fill ipie. Sometimes these gages stick. If this happens, tap it gently with the side of your hand.

9. Locate number (6). Number (6) is on the protective cover of the engine air filter. Raise the bottom of the cover. Loosen the wing nut and remove the pan. Before operations you should check inside this pan to be sure the oil is not dirty and the oil is up to but not over the fill line.

NOTE: There is no oil in this pan so you can see clearly the fill line and how the pan is constructed. On the engine you will operate in the PTF be sure that oil is in the pan and at the proper level.

10. The side panel on the right side is numbered (7). It is in the raised position. Notice how the panel is held up by the peg and latch. During operations both panels should be up to prevent overheating. When not in operation the panels should be down to protect the engine.

11. Locate number (8). This is on top at the rear of the engine. Number (8) is on the cover panel of the radiator cap. Raise the cover and look inside at the radiator cap. Before operating this engine check inside to be sure the coolant level is at least high enough to be touched by your finger. Do not fill the radiator completely full.

12. Locate number (9). This is the battery cover. Be careful when removing this cover so that you don't touch the battery terminals and short out the batteries. Remove this cover now and note how the batteries are installed. Water should be even with the fill mark indicated in the cells.

13. Locate number (10) on the left side of the engine. Raise this cover panel and locate the oil dipstick. Before starting the engine the oil should be up to the "FULL" mark on the dipstick but not over the "FULL" mark. After noting the dip stick close the panel.

14. Locate number (11) near the control panel. Just below the number (11) you see a round screw cap. Unscrew this cap and you will see an electrical outlet. This is called the battery charging receptacle. By running a slave cable from this receptacle to one on another similar unit it is possible to "jump start" or recharge the batteries quickly and easily. Replace the screw cap.

15. Locate number (12). This is on the control panel cover. Check each item on the control panel as listed below and remember all information noted for each.

a. Oil pressure Gage: On the bottom of this gage is a safety shut off reset switch. "BEFORE STARTING THE ENGINE THIS BUTTON MUST BE PRESSED TO RESET THE SWITCH". During normal operations at 1800 RPM the oil pressure should read between 40 and 50 PSI. At idle speed (400 to 600RPM) the oil pressure should read over 7 PSI.

b. Ammeter: Indicates the rate of charge or discharge to the batteries. It should show a slight charge during normal operations. If it shows any discharge it indicates that something could be wrong with the electrical system.

c. Water Temperature Gage and Safety Switch: The normal operating temperature of the engine is between 150° and 185°F. The gage incorporates a safety switch that automatically shuts off the engine if it overheats.

d. Tachometer: This gage indicates engine speed. Each mark represents 100 RPM. Idle speed is 400 to 600 RPM and normal operating speed is 1800 RPM.

e. Primer: This control is actually a hand pump that pumps raw gasoline into the intake manifold. When the engine is cold it may require you to pump this primer four or five times before starting. Do not use the primer on a hot engine as it may cause the carburetor to flood. To operate the pump, pull it all the way out then push it all the way in.

f. Throttle: To set the throttle on idle, push the RED button in and while holding it in, pull the whole throttle control all the way out (about 4 inches). After the throttle is all the way out, release the RED button and turn the handle one turn to the right. This should be set for idle speed. To increase RPM turn the handle clockwise.

g. Battery Disconnect: Turn this switch to the "ON" position before attempting to start the engine and leave it "ON" during operations.

h. Magneto Switch: The Magneto Switch is just below the Battery Disconnect Switch. On this display pump it shows that the switch should be in to start. This is a NON-STANDARD switch. On the pumps you will operate in the PTF you will have the Standard Switch. The Standard Switch must be "OUT" to be "ON" and "IN" to be "OFF". The switch must be "ON" before starting the engine and left "ON" during operations.

i. Choke: The choke control is just below the Magneto Switch. When starting a cold engine you will need to pull this out about half way and in very cold weather about three-fourths. As soon as the engine begins to run smoothly, during warm up, push the choke back in.

CAUTION: Do not leave the choke out while pumping. This will cuase overheating.

j. Starter: The starter button is just below the choke control. When starting the engine, do not press the starter more than 5 seconds at a time. Always release the starter button as soon as the engine fires.

k. Suction Gage: The suction gage measures the positive pressure coming into the pump or the vacuum pressure in cases where the pump is pulling fuel in at a faster rate than natural flow.

l. Discharge Gage: The discharge gage indicates the pressure on the fuel as it leaves the pump. A sudden increase in discharge pressure could mean a closed valve on the discharge side and a sudden drop could mean loss of prime or a ruptured line on the discharge side. NEVER OPERATE THE PUMP WITHOUT PRIME.

m. Safety Bypass Switch: This switch provides a means of overriding the water temperature and oil safety switches. It is used only in extreme emergency.

ANSWER THE FOLLOWING QUESTIONS

1. How much gasoline is put in the tank after operations?

____

2. When do you reset the oil pressure safety switch?

____

3. How high should the coolant be in the radiator before starting?

____

4. What is the throttle control position for starting?

____

5. What is the normal operating oil pressure?

____

6. What is the normal water temperature during operations?

____

7. What is idle or warm up speed?

____

8. What is normal pumping speed?

____

9. In what position is the Standard Magneto Switch "ON"?

____

10. Where should the oil level be in the sight glass on the pump drive shaft housing?

____

ANSWERS TO QUESTIONS ON PAGE #9

1. Tank should be 3/4 full.
2. Before trying to start the engine.
3. High enough to be touched by your finger.
4. All the way out, then one half turn clockwise.
5. Between 40 and 50 PSI.
6. Between 150° and 185° F.
7. 400 to 600 RPM
8. 1800 RPM
9. OUT
10. Approximately half full.

If your answers do not agree, go back and review PART TWO. If you have problems see an instructor.

PART THREE

OPERATION

NOTE: Before going to the PTF to perform an actual operation with this pump you must commit to memory all the information contained in this PART THREE. Look at the display model and memorize what you must do following this outline.

1. Before Operations Maintenance.

    a. Check bonding cable.

    b. Set out fire extinguisher.

    c. Check main bearing oil cup.

    d. Check oil level in sight glass.

    e. Check gasoline level.

    f. Check oil in air breather.

    g. Check water level in radiator.

    h. Check water level in battery.

    i. Check engine oil dip stick.

    j. Check TAMMS forms.

    k. Check for any loose, missing, or damaged parts.

2. Starting and Warm-Up Procedure: Be sure to follow this procedure in the exact sequence that is outlined.

    a. Perform before operators maintenance.

    b. Close all valves in the manifold.

    c. Gage the storage tank.

    d. Open the valves from the storage tank to the suction side of the pump including the suction valve on the pump. (Your instructor will designate which tank to use).

e. DO NOT OPEN THE PUMP DISCHARGE VALVE but open the other valves between the pump discharge and the receiving point.

f. Open both side panels and the control panel on the engine.

NOTE: You are now ready to start the pump but check with an instructor before starting.

g. Pull throttle control out to idle.

h. Pull chock out half way (only if the engine is cold).

i. Pump the fuel primer four times (only if the engine is cold).

j. Press oil pressure safety switch reset.

k. Turn battery disconnect to "ON".

l. Pull out magneto switch to "ON".

m. Press starter button. (Not more than 5 seconds).

n. When the engine starts, release the starter button and set engine throttle control so the engine idles at 600 RPM. If after three trys the engine doesn't start, repeat steps g through m. If it still doesn't start, check with your instructor.

o. When the engine is idling smoothly push the choke control in.

p. While the engine is warming up open the air eliminator valve on the pump briefly to let out any air in the pump.

3. Pumping Operation: After the pump is warmed up the instructor will give you the go ahead to pump fuel. Follow these steps.

a. Open the pump discharge valve.

b. Increase RPM to 1200.

c. When the receiving point personnel state they are receiving and you see no leaks or malfunctions, then increase RPM to 1800 RPM.

d. Watch the engine gages for any problem and watch the pipes for leaks.

NOTE: Should a problem occur idle the pump and close the discharge valve as quickly as possible and notify the instructor.

e. After the receiving point has received the fuel they need idle the pump and close the discharge valve.

f. Idle the pump five minutes before shutting it off.

4. Shut Down and After Operation Maintenance: After the pump has idled for 5 minutes then follow this procedure in the order indicated.

a. Turn Battery Disconnect to "OFF" position.

b. Push Magneto Switch in to "OFF" position.

c. After the engine has stopped completely push the throttle control in.

d. Close all the valves used in the operation including the pump suction valve.

e. Open the BLUE vent valves.

f. Gage the storage tank.

g. Perform after operations maintenance on the Engine and Pump.

NOTE: The after operations maintenance is the same as before operations except that you will return the fire extinguisher to proper storage, fill out the TAMMS forms and clean up the equipment.

When you are sure you can remember all the steps in this PART THREE and in the right sequence you are ready for PART FOUR.

PART FOUR

PRACTICAL EXERCISE

Now that you have become familiar with the six inch single stage pump, go to the Depot Area in the PTF. The instructor there will designate which pump and storage tank to use. You will work with other students in Rail Tank Car Operations and will be required to fill and empty the Rail Tank Car using the Six Inch Single Stage Pump. Follow the procedure as outlined in PART THREE of this program. Upon completion of this practical exercise, the instructor will give you the examination.

GOOD LUCK !

QMS 300.511 H-1

RAIL TANK CAR
OPERATIONS

PROPONENT DEPARTMENT: Petroleum and Field Services

October 1976

INTRODUCTION

Rail Tank Car operations are very extensive throughout the Army. As a Petroleum Supply Specialist you will, sooner or later, be involved in loading and unloading rail tank cars. During this self-paced block of instruction you will become familiar with the correct methods for loading and unloading rail tank cars. Read all your instructions carefully and follow directions closely. If you should have a question or problem, see your instructor.

OBJECTIVE

As a result of this instruction and when provided with a rail tank car, equipment and facilities, you will be able to:

1. Position the tank car, ground and bond, observing all safety precautions.

2. Inspect the tank car, sample residue innage and service for which intended.

3 Identify two methods of loading and unloading a rail tank car.

4. Load the tank car and gage with both the long pole and short pole methods.

5. Take a sample and temperature of the product after loading the tank car.

STEP 1: Get your copy of FM 10-18 then go to the rail tank car study area.

STEP 2: Turn to Chapter 6, FM 10-18 on page 6-1. Read carefully all of Chapter 6 in FM 10-18 before proceeding to the next step. Pay particular attention to the rules of safety and proper steps for loading and unloading. When you finish reading the FM, go to step 3.

STEP 3: On pages 4 thru 12 of this text you have Annex #1. This is an outline of the steps you must follow in tank car operations.

Using FM 10-18 make notes in your outline for each of the blank spaces in the outline. In the next step you will be going to the PTF to load and unload the rail car. Take good notes in your outline and fill in the blank spaces. You will be able to use this outline when you go to the next step in the PTF.

NOTE: There is a long pole and a short pole and a chart showing their use in building 11400, rail tank car study area.

STEP 4: Having completed step #3, go to the PTF to the rail tank car area and the sign that says "RAIL CAR OPERATIONS". You are now ready to familiarize yourself with the rail car and the safety precautions you must follow. Check each of the following points and if you can not find them or have a question, see your instructor.

a. Between the tracks you see the "TANK CAR CONNECTED" sign. This should be at least 25 feet but preferably 50 feet from the rail car.

b. Just in front of the wheels note the ground rod and wires.

c. Note the wooden blocks against the wheels.

d. Note the tank car mover. This is a long heavy pole with a metal jack on the end. The rail car can be moved by placing the jack on the track and against the wheel then pushing down on the handle. Do not move the rail car.

e. Note the hand wheel brake. The brakes can be locked by turning clockwise and setting the cog lock against the cog wheel.

f. Note the diamond "◊" shaped bracket at the end of the shell. There is one of these on all four sides of the rail car. There are signs to be placed in these brackets. One side says "FLAMMABLE" the other side says "DANGEROUS WHEN EMPTY."

g. Go around to the right side of the rail car and note how the fill stand is bonded to the rail car.

h. Note the bottom drain with gate valve and elbow attached.

i. Note sump pit under the drain.

j. Note the plug valves on the 6" pipe going to the overhead fill pipe.

k. Climb up on the fill stand and note the fire extinguisher.

l. Note the filling tube and the operating valve with rope attached.

m. Open the hatch cover and note the Bottom Drain Valve Handle inside. Turning the valve all the way to the right opens the valve. To the left close it. Try this one time.

n. Note the long pole and short pole used for gaging on the fill stand. You will use these during the practical exercise.

o. Note that one bolt on the hatch has a slot in it. This is where the seal is put after the rail car is loaded.

p. Go back to the ground and between the fill stands you will find a sump pit beside which is a six inch pipe coming out of the ground with two four-inch quick couple inlets. This is where the fuel line is connected when you bottom drain discharge from the rail car. The hose for this is in a trough beside the tracks.

STEP 5: Now that you located all the key points on the rail car use your outline and rehearse in your mind all the steps involved in loading and unloading operations. After you are sure of what you have to do in these operations notify your instructor that you are ready for your practical exercise.

STEP 6: Practical Exercise: You will be working with other students at the Depot Terminal. Follow the instructions of the instructor and you will load and unload the tank car.

STEP 7: After your finish with your practical exercise the instructor will afford you a question and answer period. If you have any questions about what you have learned now is the time to clear it up.

STEP 8: Your examination at the end of the practical exercise will cover all you have learned on rail tank cars. There will be special emphasis on gaging, sampling, safety, spotting the rail car, and different ways to load and unload the rail car. Review your notes and if you need to, go back and get FM 10-18 and improve your notes. This concludes this program until your exam.

GOOD LUCK!

ANNEX #1

PETROLEUM SUPPLY SPECIALIST

TERMINAL OPERATIONS - RAIL TANK CARS

Objectives: As a result of this instruction and when provided with a rail tank car, equipment and facilities, the student will be able to:

1. Position the tank car, ground and bond, observing all safety precautions.

2. Inspect the tank car, sample residue innage and service for which intended.

3. Identify two methods for loading and unloading a rail tank car.

4. Load the tank car and gage with both the long pole and short pole methods.

5. Take a sample and temperature of the product after loading the tank car.

All as prescribed in TM 10-1101 and FM 10-18.

LESSON OUTLINE

1. Description of tank cars and loading/unloading facilities.

  a. General

    (1) Dome

    (2) Shell

  b. Loading and unloading site.

    (1)

(2)

(3)

(4)

(5)

c. Loading facilities equipment.

(1) Storage tanks

(2) Transfer pump

(3) Filter/separator

(4) Overhead loading rack for loading through the dome.

(a)

(b)

(c)

(d)

    d. Unloading facilities equipment.

2. Preparation for loading.

    a. Sampling

    b. Spotting rail car.

        (1)

        (2)

        (3)

        (4)

        (5)

        (6)

        (7)

        (8)

    c. Removing dome cover.

(1)

(2)

(3)

(4)

(5)

d. Inspecting tank car.

(1)

(2)

(3)

(4)

(5)

3. Loading Operation.

a. Loading through dome (overhead loading).

662

(1)

(2)

(3) Make sure bottom outlet valve is closed.

(a)

(b)

(4)

(5)

(6)

(a)

(b)

b. Bottom loading.

4. After-loading operation.

676

a.

b.

c.

d.

e.

f.

5. Unloading operations.

a.

b.

c.

d.

e.

f.

g.

664

6. After unloading operation.

   a.

   b.

   c.

   d.

   e.

   f.

   g.

   h.

7. Tank car gaging equipment and gaging methods

   a. Use of the tank car gage stick.

      (1) The gage stick is made of hardwood or other suitable material.

         (a)

678

(b)

(c)

(2) The long pole gage stick is about 10 ft. long.

(a)

(b)

b. Gaging methods.

(1)

(2)

8. Sampling before and after loading and unloading.

a.

b.

c.

9. Sealing

a. After filling a tank car and before you ship it, you must seal it with a rail car seal.

(1)

(2)

b. Before unloading a tank car, you must check the seals.

(1)

(2)

9. Summary and review.

667

QMS 300.510 PT

PS-D-9-PFS

PROGRAMMED TEXT
TANK MAINTENANCE
D-9

PROPONENT DEPARTMENT: Petroleum and Field Services

April 1977

269681

OBJECTIVE:

As a result of this instruction and when provided with a mine safety set, explosimeter, and safety tools, the student will be able to:

1. Fit the fresh air mask of the mine safety set to his face.
2. Fit the safety harness of the mine safety set to his body.
3. Identify the uses of the explosimeter in detecting flammable vapors.
4. Operate the explosimeter in inspecting a hazardous area.
5. Perform external maintenance on petroleum storage tanks and accessories.

All as described in TM's 5-678 and 10-1109.

INSTRUCTIONS:

Read this program carefully and follow all of the instructions given. If you have any problems, contact your instructor. You will be tested on the material covered in this program.

INTRODUCTION:

In any terminal operation there are large amounts of bulk fuels that must be stored, issued or received. To handle this fuel, large storage tanks are necessary and like all other equipment you use and handle these tanks must be maintained.

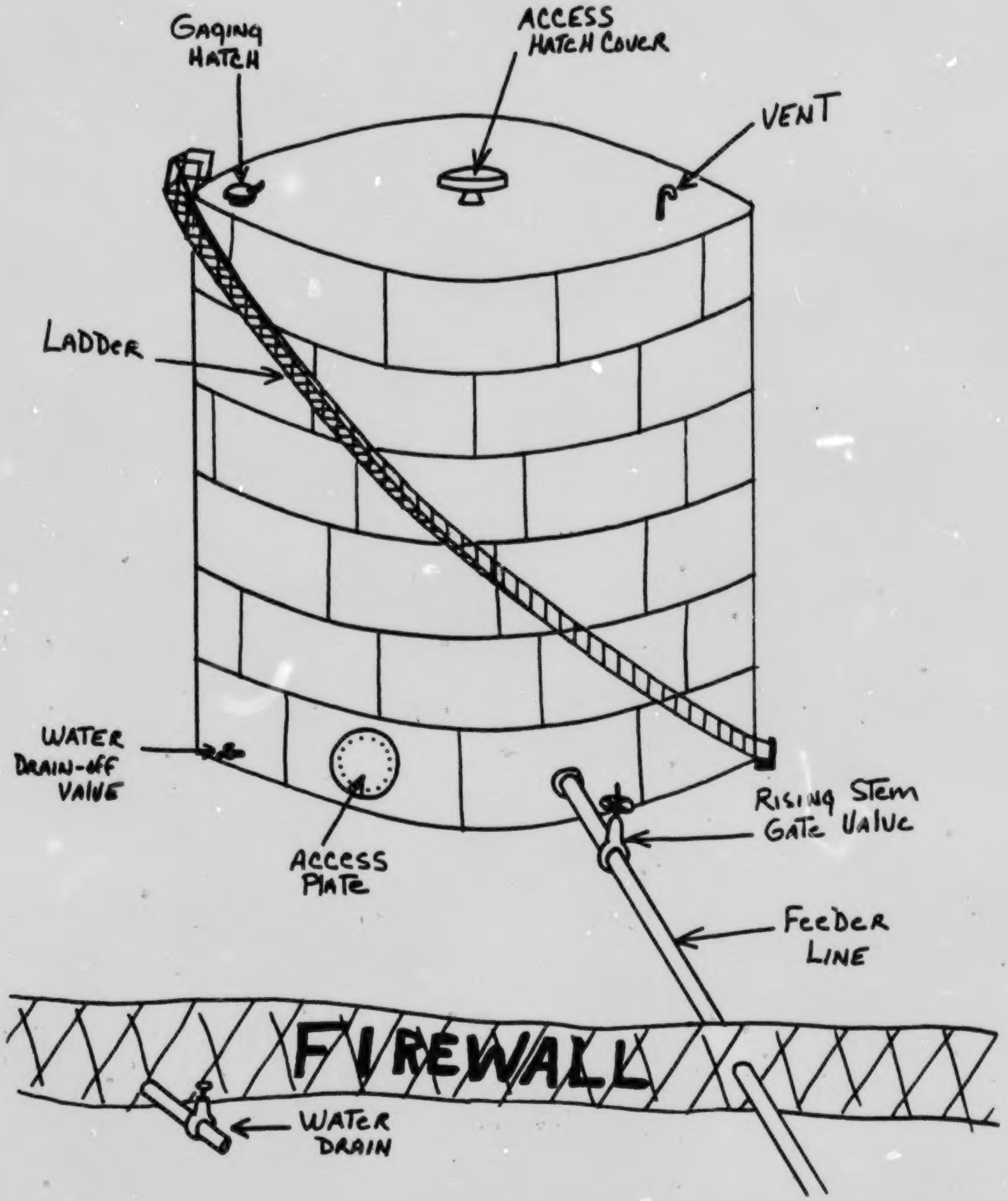
There are many different types of terminal storage tanks. The most common tank is the welded steel or bolted steel above ground tanks. There are also many underground tanks made of welded steel or concrete. Some have floating roofs. As a 76W working in a terminal you will have to perform inspections and maintenance on these tanks.

When inspecting a storage tank there are several things to check. Study the following list of checks closely:

1. Check the tank carefully for leaks.
2. Check the tank for rust spots or exposed metal.
3. Check all valves to see if they are operational and not leaking.
4. Check the ladder to insure that it is safe to use and securely attached to the tank.
5. Check the hinges on sampling and gaging hatches.
6. Check the vents and make sure they are clear and operational.
7. Check the firewall for deterioration.
8. Check the water drain off pipe making sure it is clear and operational.

Some storage tanks require special treatment but time doesn't permit a study on each type of tank used by the Army. When you get to your duty station familiarize yourself with each tank. Anytime you discover something wrong notify your NCOIC immediately.

670


Gaging Hatch
Access Hatch Cover
Vent
Ladder
Water Drain-off Valve
Access Plate
Rising Stem Gate Valve
Feeder Line
FIREWALL
Water Drain

684

PRACTICAL EXERCISE

This practical exercise requires you to use common sense and what you have learned in previous instruction.

SITUATION: You have just inspected a storage tank in a tank farm and found the following things wrong. You notified your NCOIC and he told you to take care of it.

REQUIREMENT: Read each problem and in your own words state what you would do to correct the situation.

1. The gate valve on the inlet pipe is leaking around the stem.

2. The handle on the water drain globe valve is broken.

3. The ladder has several bare spots and the metal is beginning to rust.

4. The cotter pin on the gaging hatch hinge is rusted.

5. A rabbit has decided to set up housekeeping in the water drain pipe in the firewall.

ANSWERS TO PRACTICAL EXERCISE:

If you don't agree with these solutions or have a better solution, see an instructor and discuss it.

1. Try to stop the leak by tightening the packing gland nuts. If that doesn't work then repack the valve.

2. Replace the handle.

3. Clean the bare spots with a wire brush, solvent and dry rags, then paint the spots with paint set aside for this purpose.

4. Replace the cotter pin with a new one.

5. Remove the rabbit and nest from the pipe then put a wire screen or similar device over the end of the pipe to prevent the rabbit's return.

SAFETY EQUIPMENT

At some future date you may be required to enter a storage tank, possibly for cleaning. Inside a storage tank you will find toxic or irritant dusts and fumes. In order to protect you in the tank there is special equipment that must be worn.

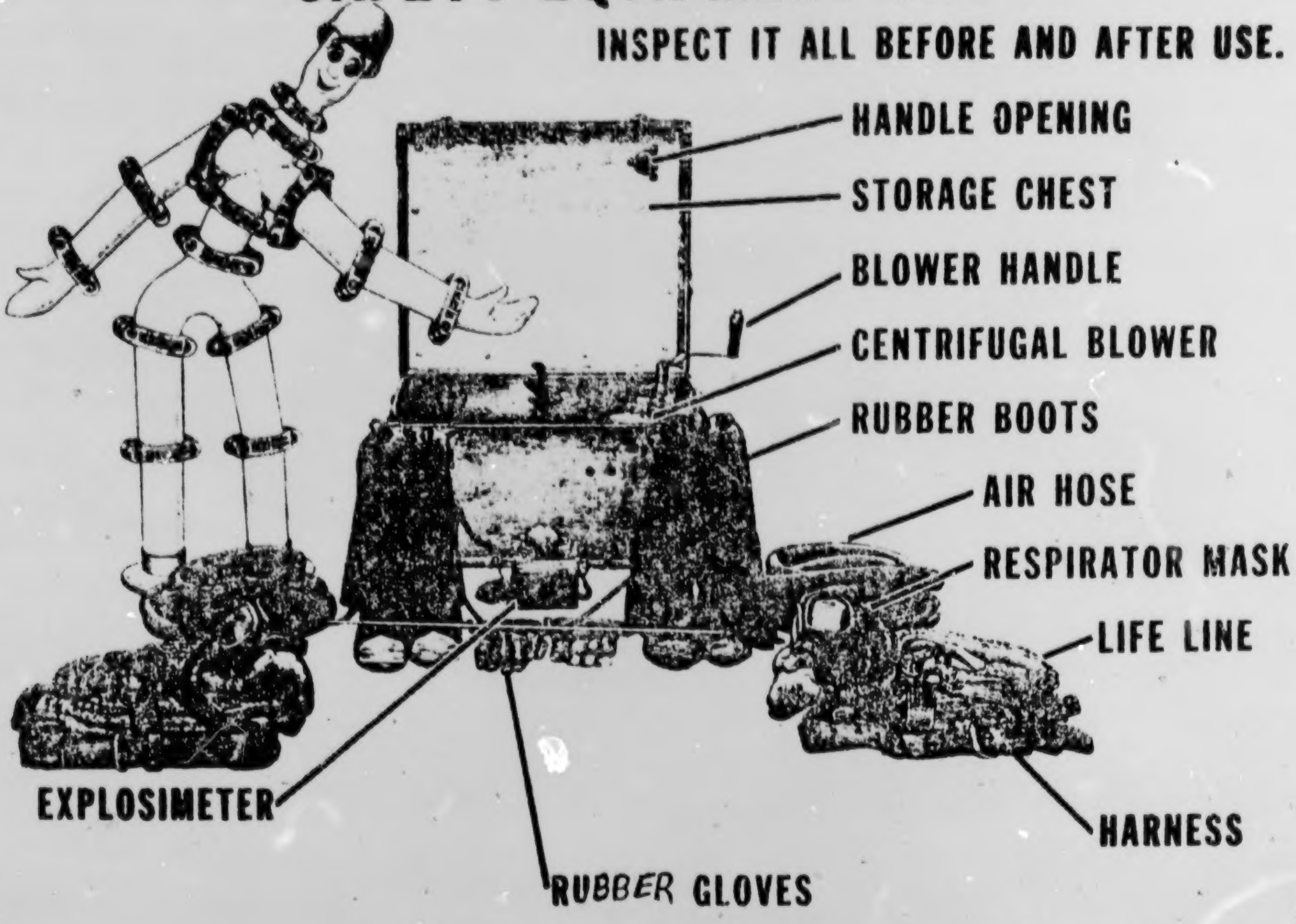
NOTE: Go to the study area for tank maintenance in building 11400.

The next step will be to work with a buddy and assembly the safety equipment and put it on. Study the pictures and captions on the following pages closely and put on the equipment as you see it in the pictures.

NOTE: When wearing a mask your buddy must keep turning the blower handle (air pump) in order for you to get air.

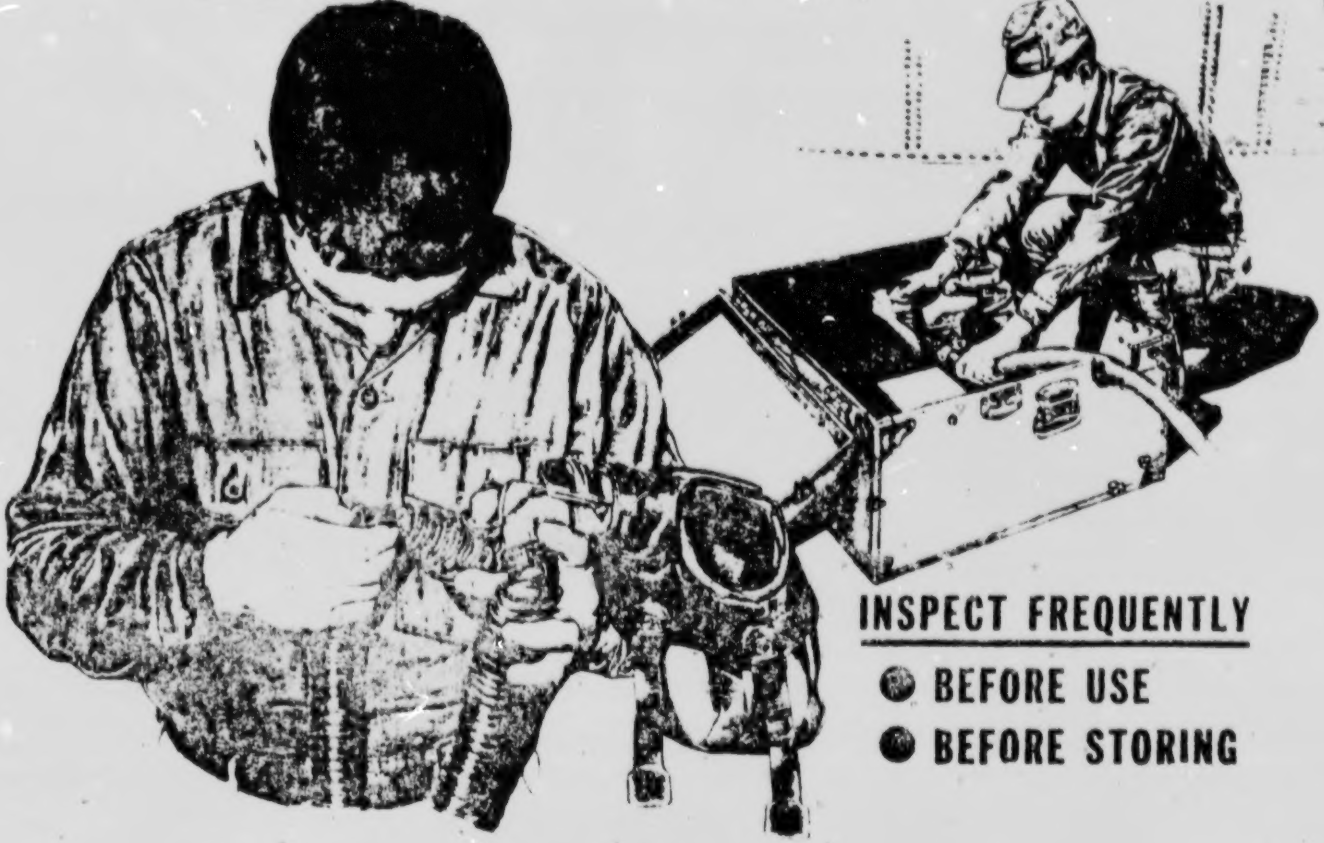
SAFETY EQUIPMENT SET

INSPECT IT ALL BEFORE AND AFTER USE.


HANDLE OPENING
STORAGE CHEST
BLOWER HANDLE
CENTRIFUGAL BLOWER
RUBBER BOOTS
AIR HOSE
RESPIRATOR MASK
LIFE LINE
HARNESS
RUBBER GLOVES
EXPLOSIMETER
277

FRESH-AIR RESPIRATOR

THE **ONLY** EQUIPMENT RECOMMENDED FOR USE INSIDE TANKS



INSPECT FREQUENTLY

- BEFORE USE
- BEFORE STORING

MAKE NEEDED REPAIRS IMMEDIATELY

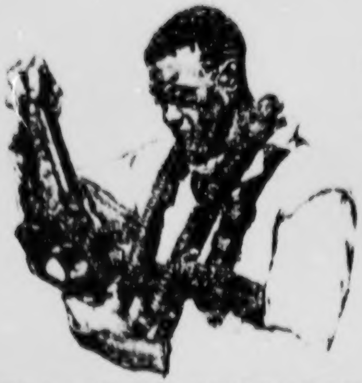
626

278

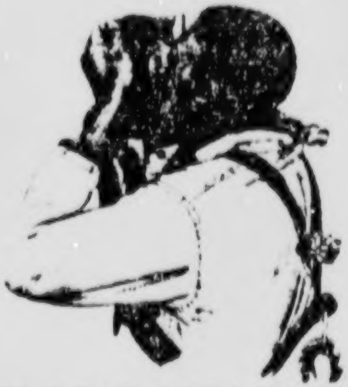
692

691

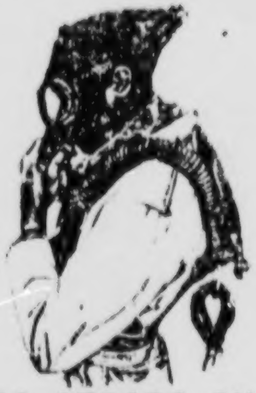
PUTTING ON THE AIR MASK



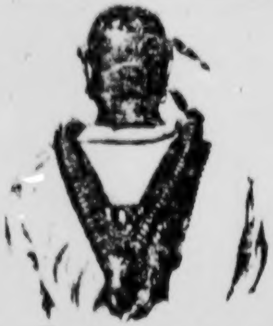
PULL HEAD STRAPS TO FULL LENGTH



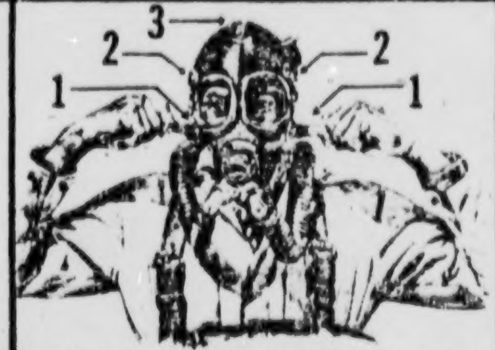
PUT YOUR CHIN IN THE MASK FIRST



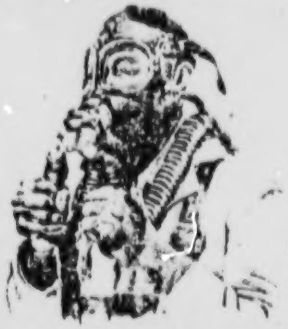
PULL STRAPS OVER YOUR HEAD



PLACE FLAT HEAD PIECE ON BACK OF YOUR HEAD



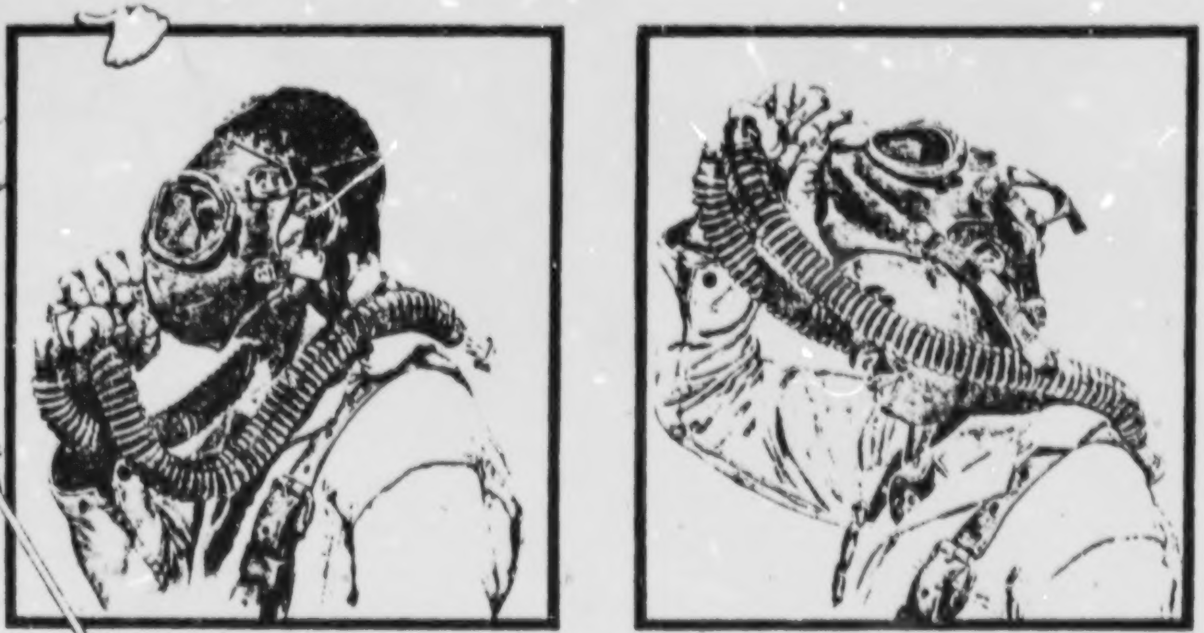
PULL HEAD STRAPS IN ORDER: 1 2, AND 3



TEST FIT: SQUEEZE HOSE & BREATH IN

REMOVING THE AIR MASK

- GRIP MASK UNDER VALVE AND HOSE CONNECTION AND PULL DOWN, OUT, AND UP--AWAY FROM YOUR FACE.

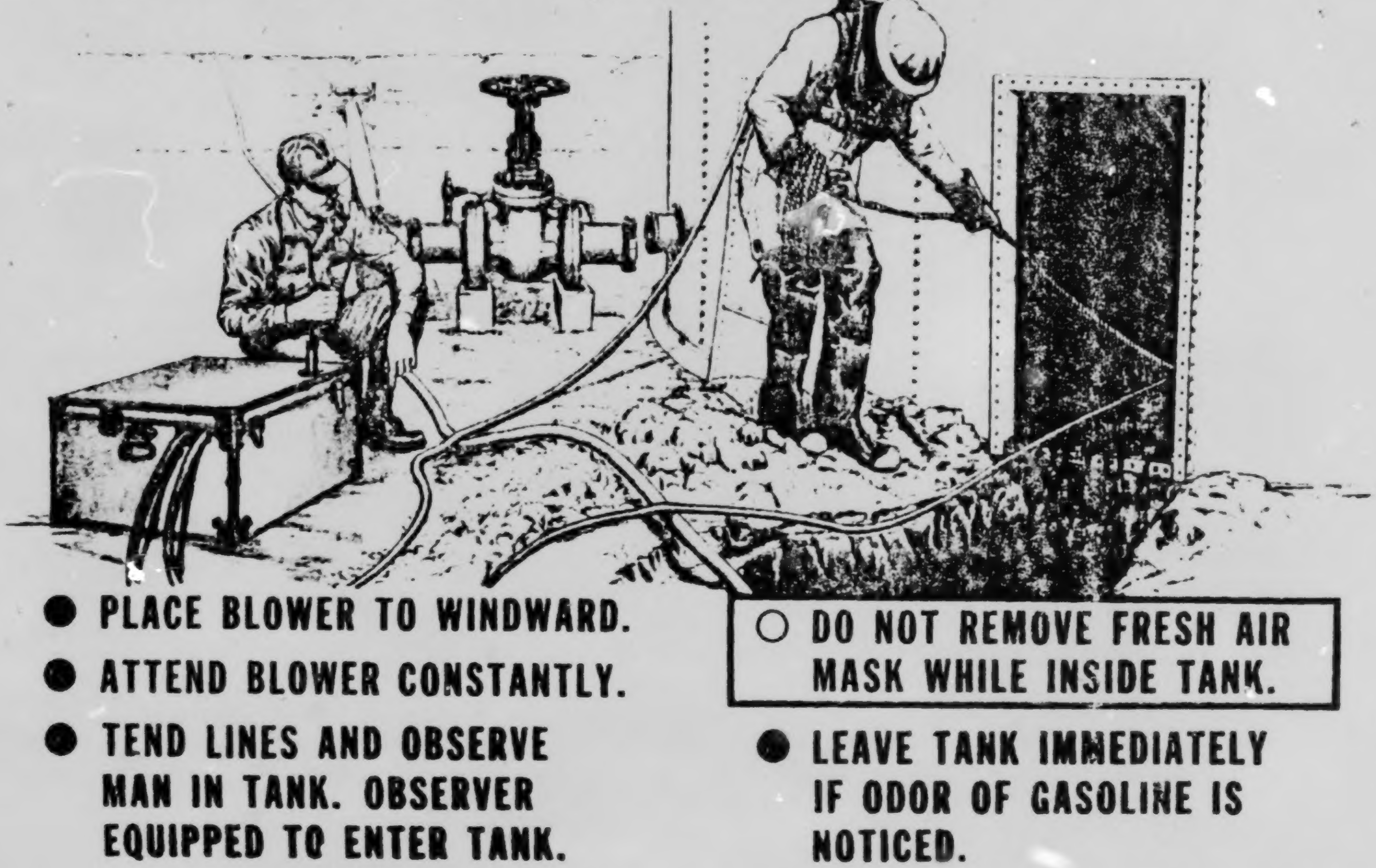


DRY INSIDE OF MASK IMMEDIATELY.
USE A CLEAN CLOTH.

695

696 C

USE AND CARE
OF RESPIRATORY EQUIPMENT



● PLACE BLOWER TO WINDWARD.

● ATTEND BLOWER CONSTANTLY.

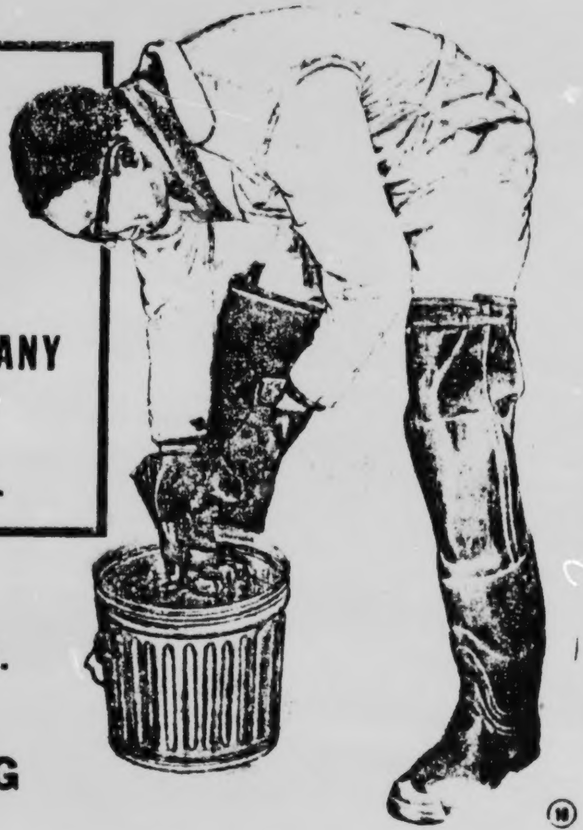
● TEND LINES AND OBSERVE MAN IN TANK. OBSERVER EQUIPPED TO ENTER TANK.

○ DO NOT REMOVE FRESH AIR MASK WHILE INSIDE TANK.

● LEAVE TANK IMMEDIATELY IF ODOR OF GASOLINE IS NOTICED.

USE AND CARE OF RESPIRATORY EQUIPMENT (CON)

- DO NOT STEP OVER LINES.
- DO NOT WALK LINES AROUND COLUMNS OR OBSTRUCTIONS.
- HAVE SUFFICIENT PERSONNEL AVAILABLE AND EQUIPPED FOR ANY EMERGENCY.
- RELIEVE WORKERS FREQUENTLY.

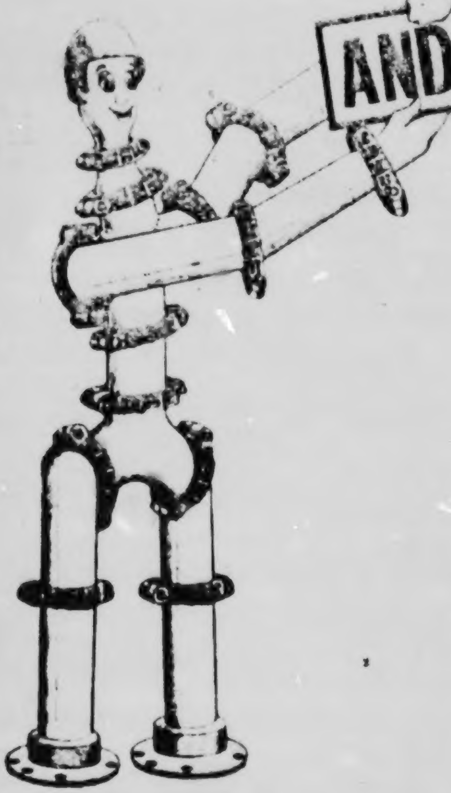


- CLEAN AND DRY ALL EQUIPMENT AFTER USE.

NOTE: WASH GLOVES BEFORE REMOVING

OTHER PROTECTIVE EQUIPMENT

AND CLOTHING



- GOGGLES - TIGHTFITTING
- HELMETS - ALUMINUM
- OUTER GARMENTS - WHITE COVERALLS
- LIGHTING - EXPLOSIONPROOF
- TOOLS - SPARKPROOF
- CANISTER GAS MASK - USE ONLY OUTDOORS

DO NOT SUBSTITUTE FOR FRESH-AIR RESPIRATORY EQUIPMENT.

EXPLOSIMETER

There is another piece of equipment in the safety equipment set. This is the explosimeter. Before entering a storage tank the tank must be vapor free and to determine whether it is or not you must use the explosimeter.

As you learned in safety and handling, during the introduction to the course, you know that for fumes to be combustible they must be in a range of 1% to 8% by volume mixed with air. In other words if the percent of fumes is between one and eight percent you have a very explosive mixture. One spark and BOOM! For you to enter the storage tank at all the percent of fumes must be less than one percent.

The explosimeter only measures from zero to one percent of the fuel to air mixture. That means if the explosimeter reads 100% you have a one percent fuel to air mixture and remember 1% to 8% is explosive.

Below one percent it is safe to enter the tank wearing protective clothing. The percentage of fumes below one percent or below 100% on the explosimeter scale determines what equipment you must wear and how long you can stay in the tank.

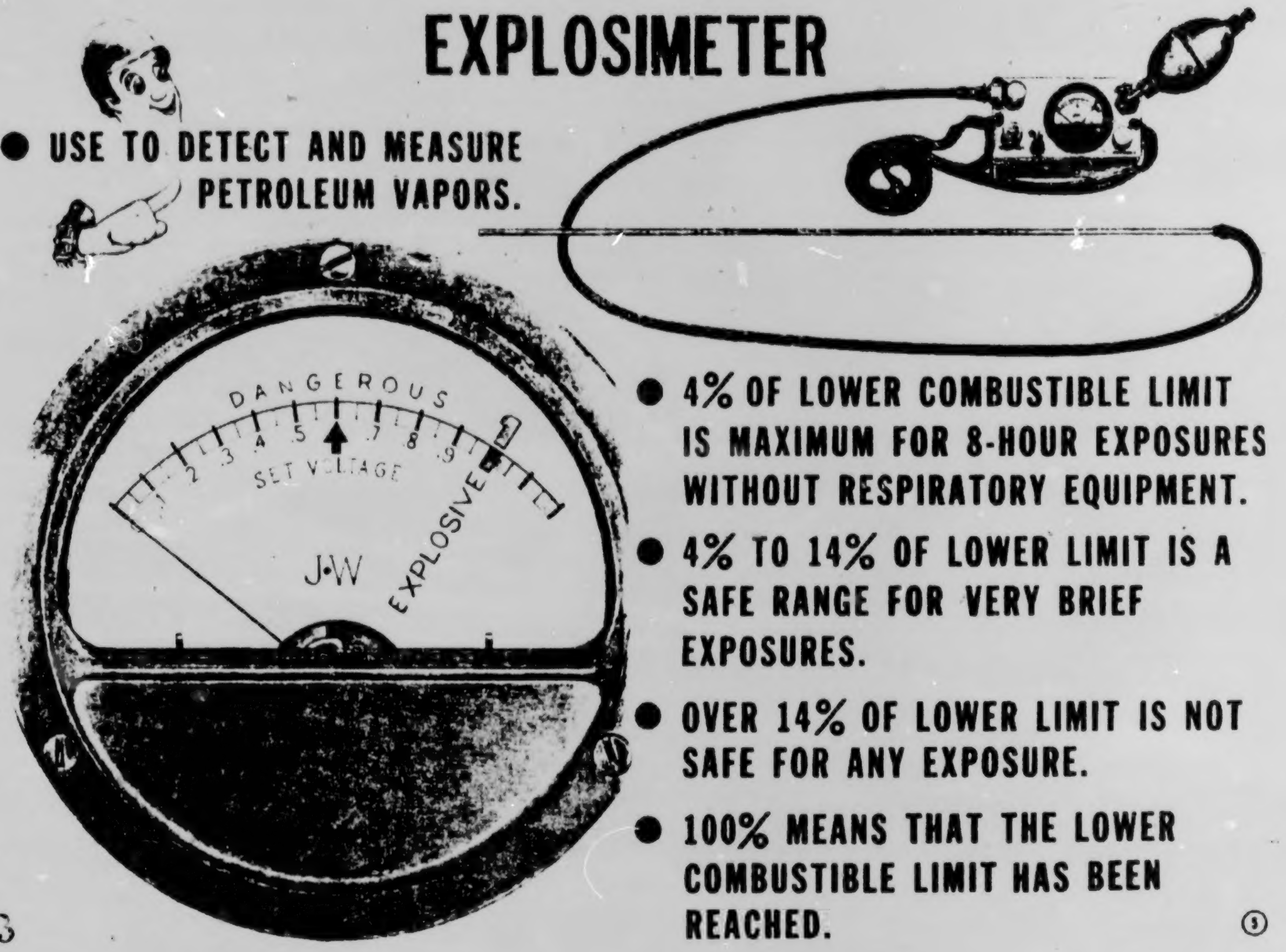
If the explosimeter reads below 4%, it is safe to work in the tank without a respirator for up to 8 hours. From 4% to 14% on the explosimeter you can enter the tank for short periods of time without the respirator. From 14% to 60% on the explosimeter you must wear the respirator at all times. Over 60% on the scale is considered unsafe working conditions. Remember 100% on the explosimeter means you have reached a highly explosive combustible mixture.

NOTE: Even when its safe to enter the tank without a respirator, you must wear a dust mask.

The directions for operating the explosimeter are found in the cover over the meter. Examine the meter and read the instructions closely.

Look at the pictures and study the captions on the next four pages closely.

EXPLOSIMETER


DANGEROUS
.1 .2 .3 .4 .5 .7 .8 .9
SET VOLTAGE
J·W
EXPLOSIVE

- USE TO DETECT AND MEASURE PETROLEUM VAPORS.
- 4% OF LOWER COMBUSTIBLE LIMIT IS MAXIMUM FOR 8-HOUR EXPOSURES WITHOUT RESPIRATORY EQUIPMENT.
- 4% TO 14% OF LOWER LIMIT IS A SAFE RANGE FOR VERY BRIEF EXPOSURES.
- OVER 14% OF LOWER LIMIT IS NOT SAFE FOR ANY EXPOSURE.
- 100% MEANS THAT THE LOWER COMBUSTIBLE LIMIT HAS BEEN REACHED.

285

703

⑤ 683

704

NEED FOR VAPOR-FREEING

SAFETY OF CLEANING PERSONNEL

BEWARE OF THE TOXIC AND EXPLOSIVE ATMOSPHERE AND OF OXYGEN DEFICIENCY WITHIN TANKS.

- **PETROLEUM VAPOR**
  IN ALL TANKS WHICH HAVE HELD PETROLEUM PRODUCTS
- **TETRAETHYLLEAD VAPOR**
  IN ALL TANKS THAT HAVE HELD LEADED GASOLINE
- **HYDROGEN SULFIDE**
  IN ALL TANKS THAT HAVE PRODUCT OF HIGH SULFUR CONTENT
- **OXYGEN DEFICIENCY**
  RESULT OF OXIDATION IN AN EMPTY, CLEAN TANK

706

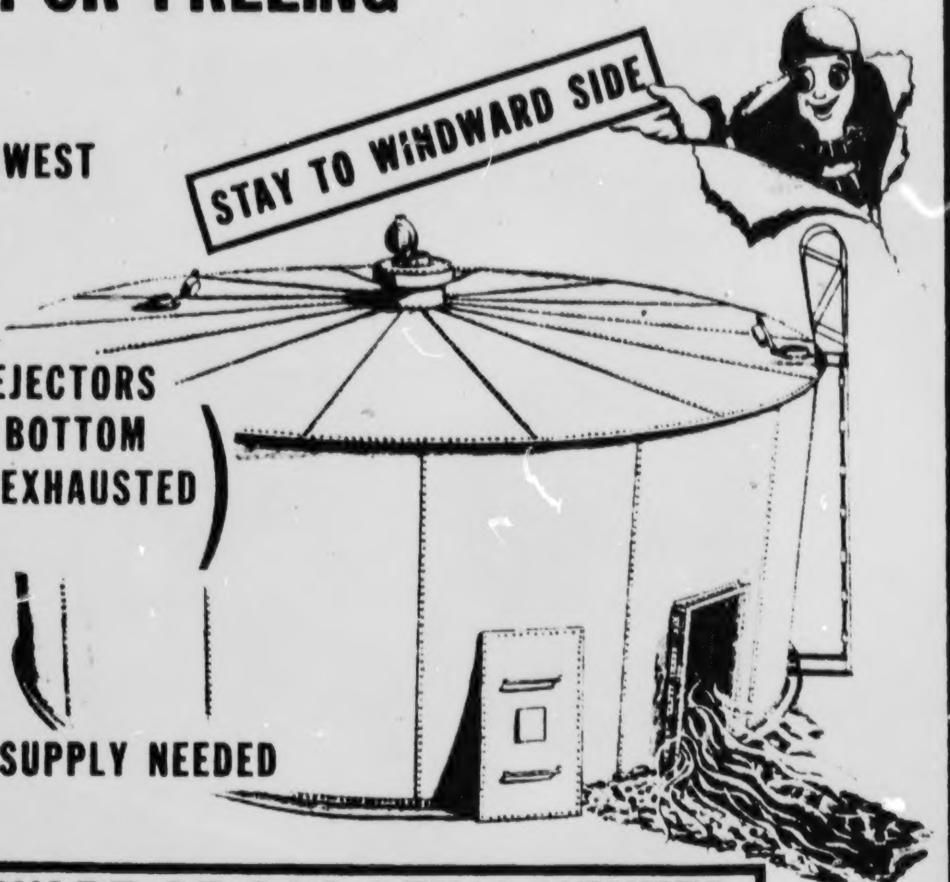
⑱

METHODS OF VAPOR-FREEING

- NATURAL VENTILATION
  SIMPLEST BUT SLOWEST

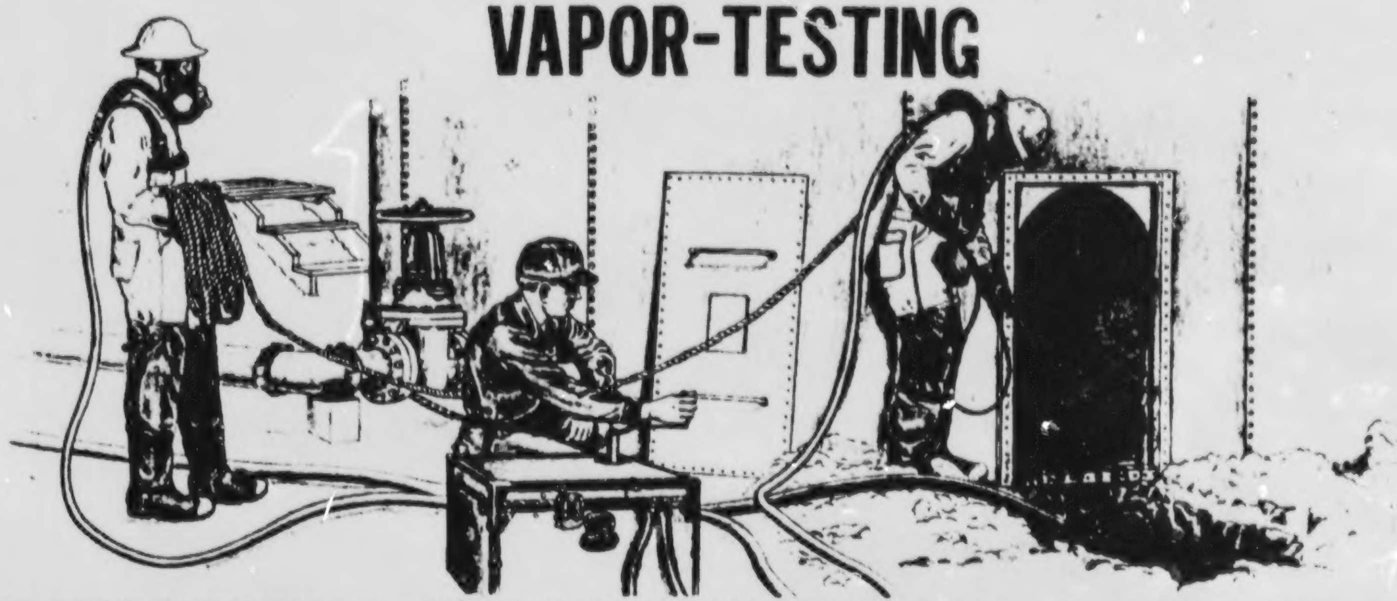
- FORCED VENTILATION
  - FASTER
  - USE BLOWERS OR EJECTORS
    (AIR FORCED IN AT BOTTOM TANK OPENING OR EXHAUSTED AT TOP OPENING)

- WATER DISPLACEMENT
  - MOST EFFECTIVE
  - UNLIMITED WATER SUPPLY NEEDED



CAUTION: BEWARE OF GAS BEING VENTED

VAPOR-TESTING



- TEST FREQUENTLY DURING VENTILATION WHERE VAPOR IS LEAVING THE TANK.
- WHEN EXPLOSIMETER SHOWS 14%, BEGIN INTERIOR TESTING AT ABOUT ONE FOOT ABOVE THE SLUDGE.
- AT A 4% READING, THE TANK CAN BE ENTERED WITHOUT FRESH-AIR EQUIPMENT.

CAUTION: USE FRESH-AIR EQUIPMENT IF TANK CONTAINS TETRAETHYLLEAD VAPOR OR HYDROGEN SULFIDE.

- TEST PERIODICALLY WHILE CLEANING

708

709

TANK CLEANING

In this school you will not be required to clean any storage tanks but you should be familiar with the procedures involved as you may be assigned to a tank cleaning team. Study the pictures and captions on the following pages closely.

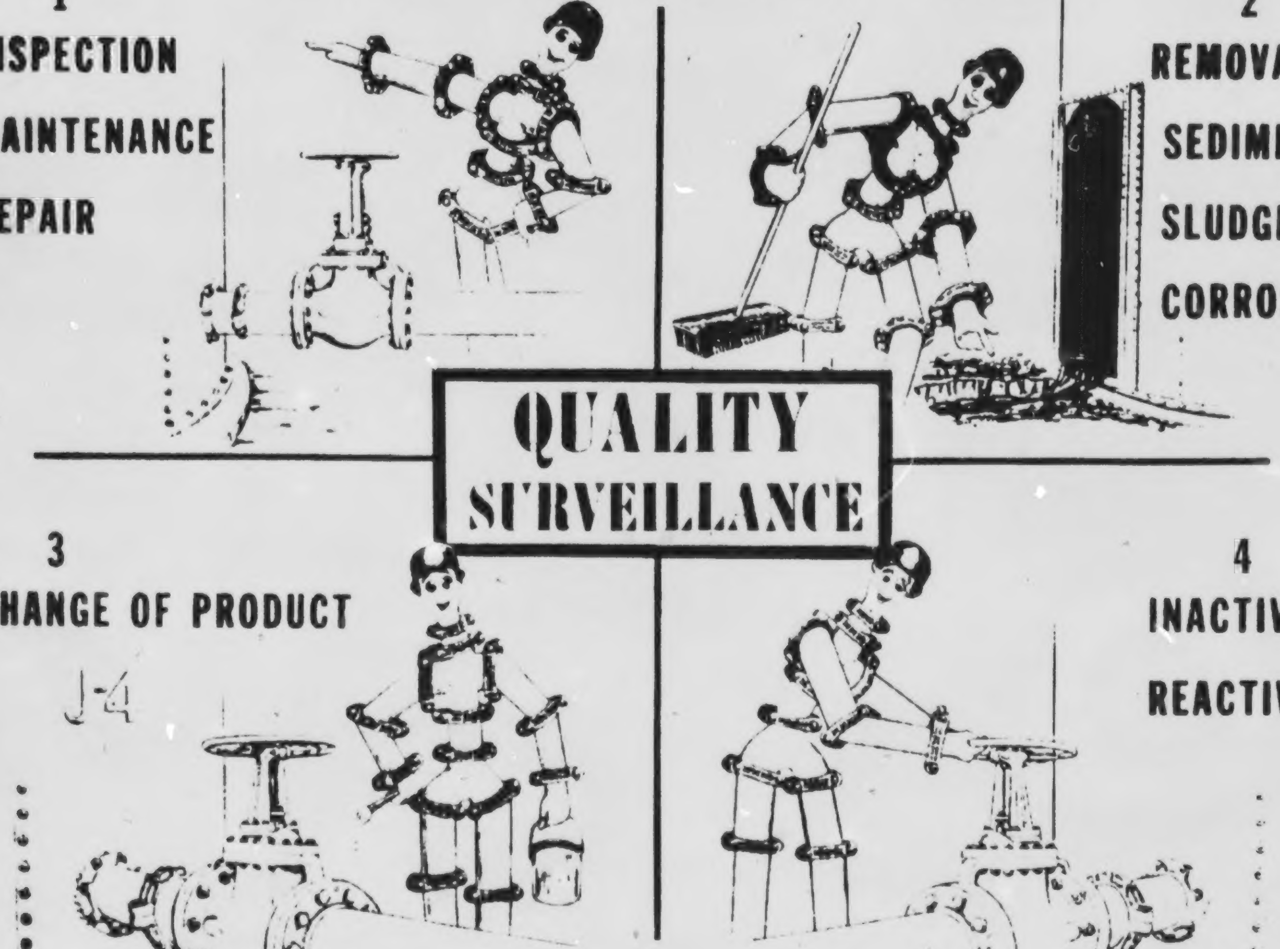
PETROLEUM STORAGE TANK CLEANING

A RESPONSIBILITY OF THE USING ORGANIZATION OR UNIT

- **RECOGNIZE HAZARDS**
- **OBSERVE PRECAUTIONS**
- **RESPECT EQUIPMENT**

REMEMBER: ALL TANKS ARE DANGEROUS

NEED FOR TANK CLEANING



1

INSPECTION

MAINTENANCE

REPAIR

2

REMOVAL OF

SEDIMENT

SLUDGE

CORROSION

QUALITY SURVEILLANCE

3

CHANGE OF PRODUCT

4

INACTIVATE

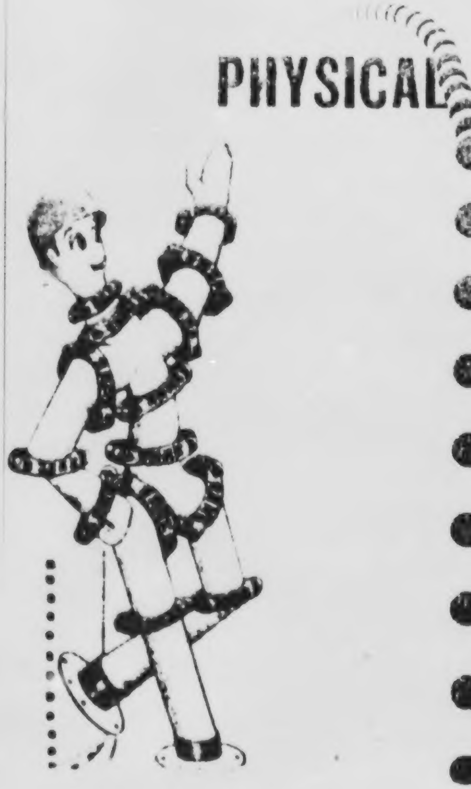
REACTIVATE

SAFETY PRECAUTIONS

FIRE AND HEALTH HAZARDS:

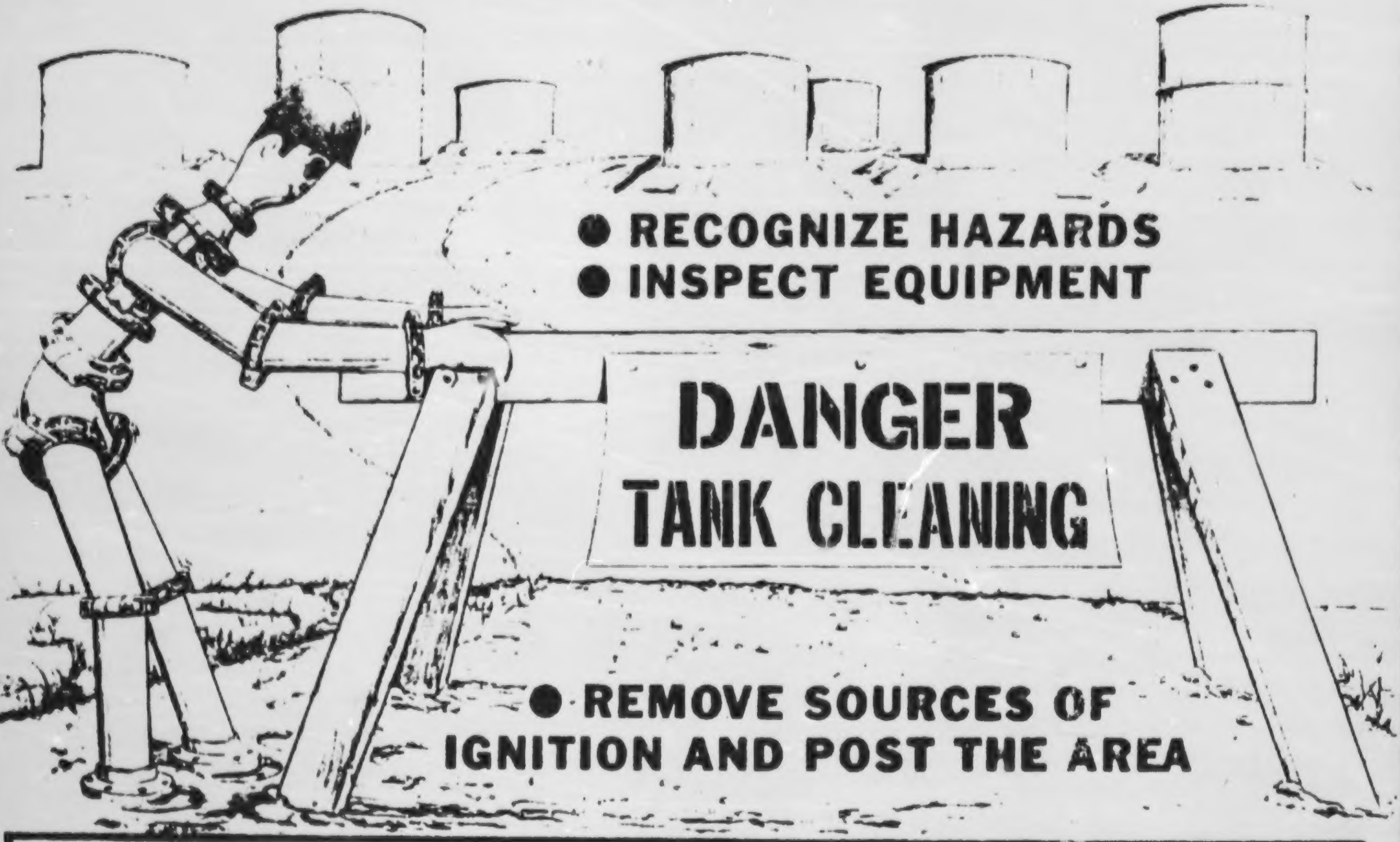
- OBSERVE PRECAUTIONS EXPLAINED IN TM 10-1101

PHYSICAL HAZARDS:



- LOOSE LADDERS AND STAIRWAYS
- THIN ROOF PLATES
- WEAKENED LINE BLANKS
- LOOSE FIXTURES
- SWING LINES
- SLIPPERY TANK FLOORS
- PIPE AND FITTINGS
- LAMP CORDS
- TOOLS (HANDLING)

PREPARATION FOR CLEANING

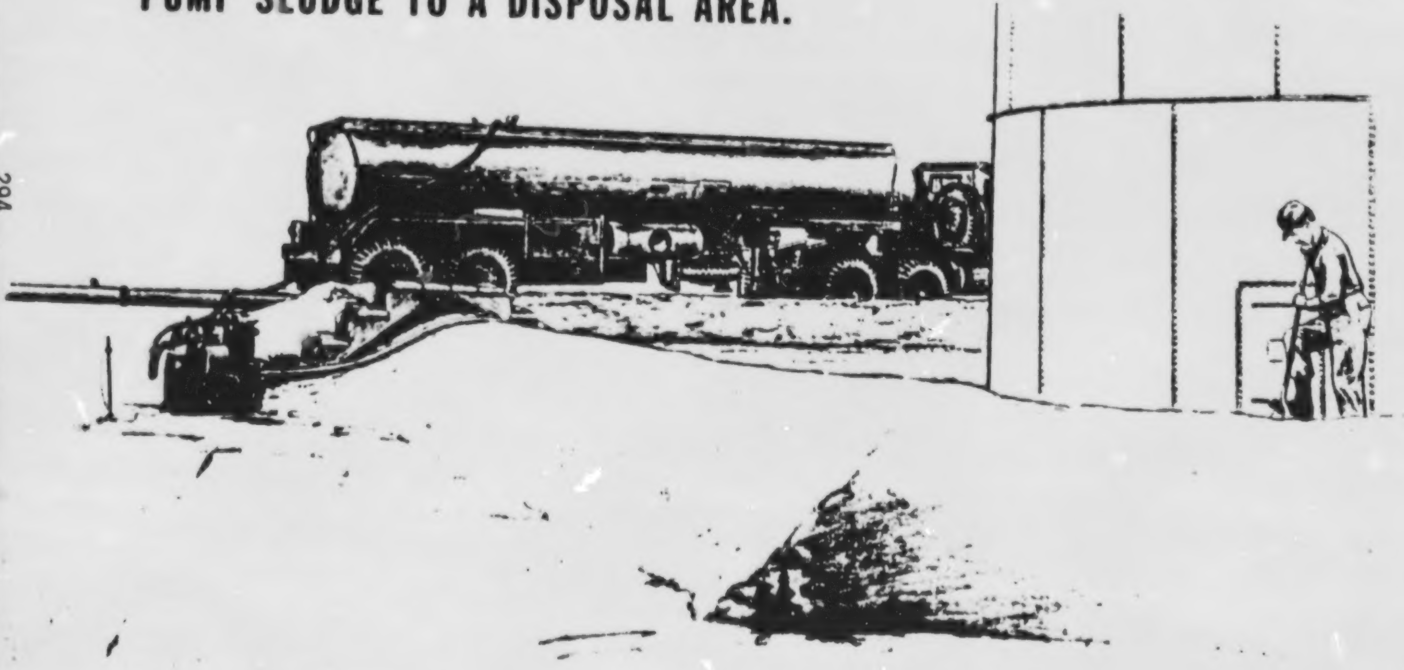

DANGER
TANK CLEANING

- RECOGNIZE HAZARDS
- INSPECT EQUIPMENT
- REMOVE SOURCES OF IGNITION AND POST THE AREA

DO NOT START TANK CLEANING IF AN ELECTRICAL STORM IS THREATENING. ⑫

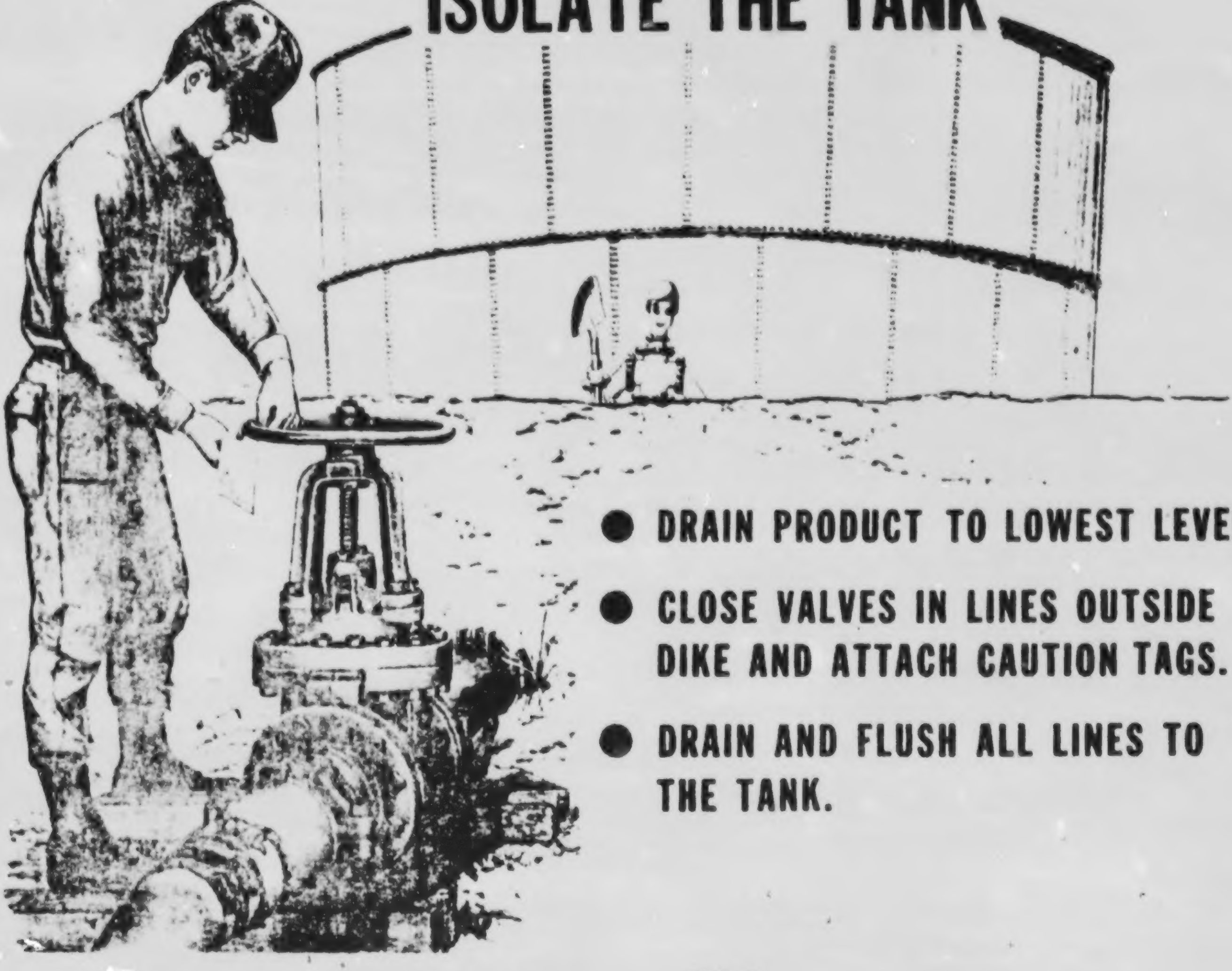
PREPARATION FOR CLEANING (CON)

- DIG A SUMP NEAR THE CLEANOUT DOOR.
- PLACE A PUMP OUTSIDE THE DIKE.
- PLACE A TANK VEHICLE TO RECEIVE THE SLUDGE, OR PREPARE TO PUMP SLUDGE TO A DISPOSAL AREA.



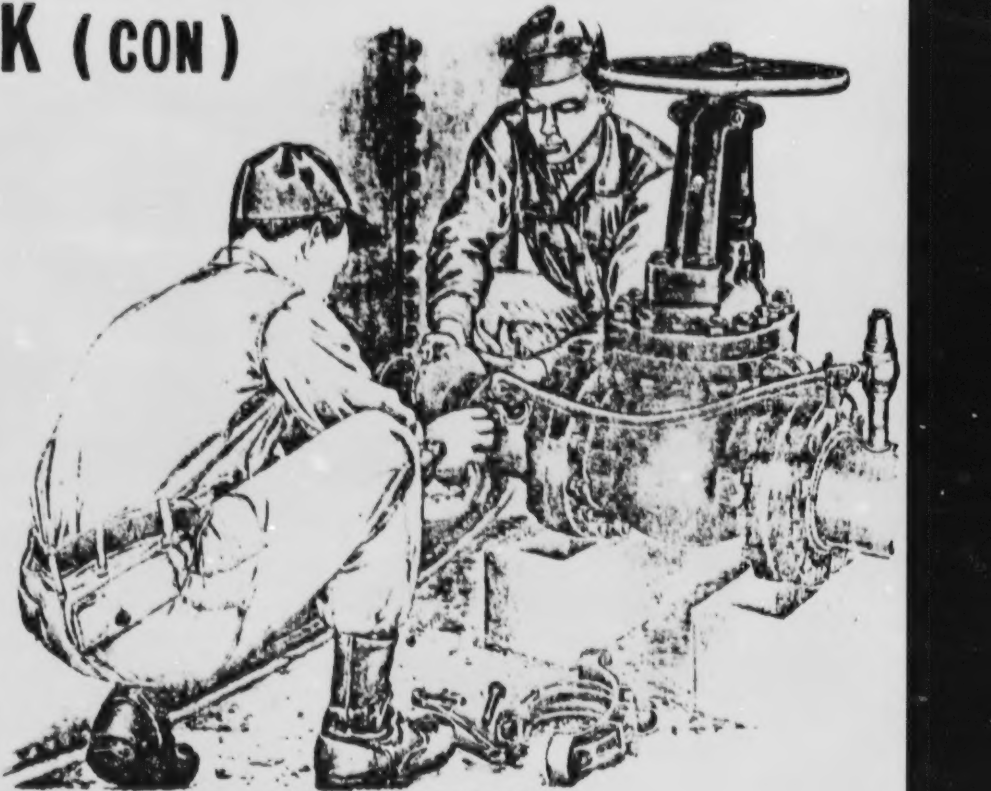
⑬

ISOLATE THE TANK

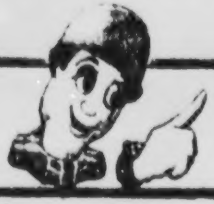


- DRAIN PRODUCT TO LOWEST LEVEL.
- CLOSE VALVES IN LINES OUTSIDE DIKE AND ATTACH CAUTION TAGS.
- DRAIN AND FLUSH ALL LINES TO THE TANK.

ISOLATE THE TANK (CON)



- BLANK OFF LINES LEADING TO THE TANK.
- USE BLIND FLANGES, FIGURE 8 BLINDS, OR SLIP JOINT BLINDS.
- PUMP ALL LIQUID SLUDGE FROM THE TANK THROUGH THE FEEDER LINE OPENING.
- THE TANK IS NOW READY TO BE OPENED.



CAUTION: AVOID BREATHING THE TANK VAPOR

⑮

CLEANING THE STORAGE TANK

CAUTION – A GAS-FREE TANK IS NOT NECESSARILY LEAD-FREE

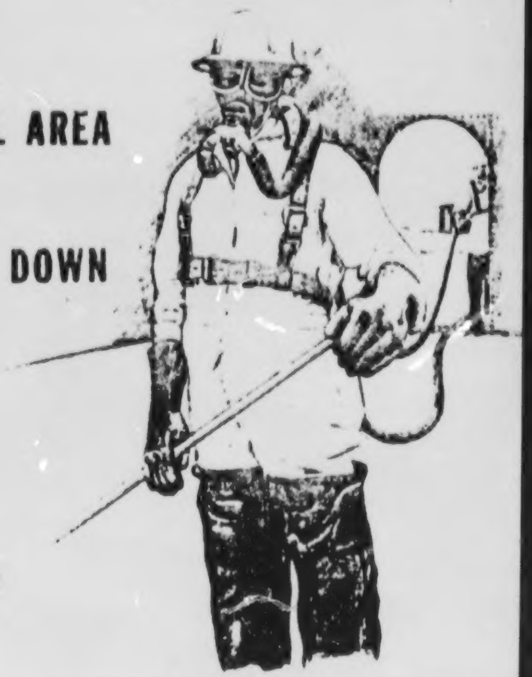
REMOVE SLUDGE

● PUMP LIQUID SLUDGE FROM SUMP TO DISPOSAL AREA OR TO A TANK VEHICLE.

● USE A HIGH-PRESSURE WATER HOSE TO KNOCK DOWN LOOSE RUST AND SCALE.

CONTINUE PERIODIC VAPOR-TESTING

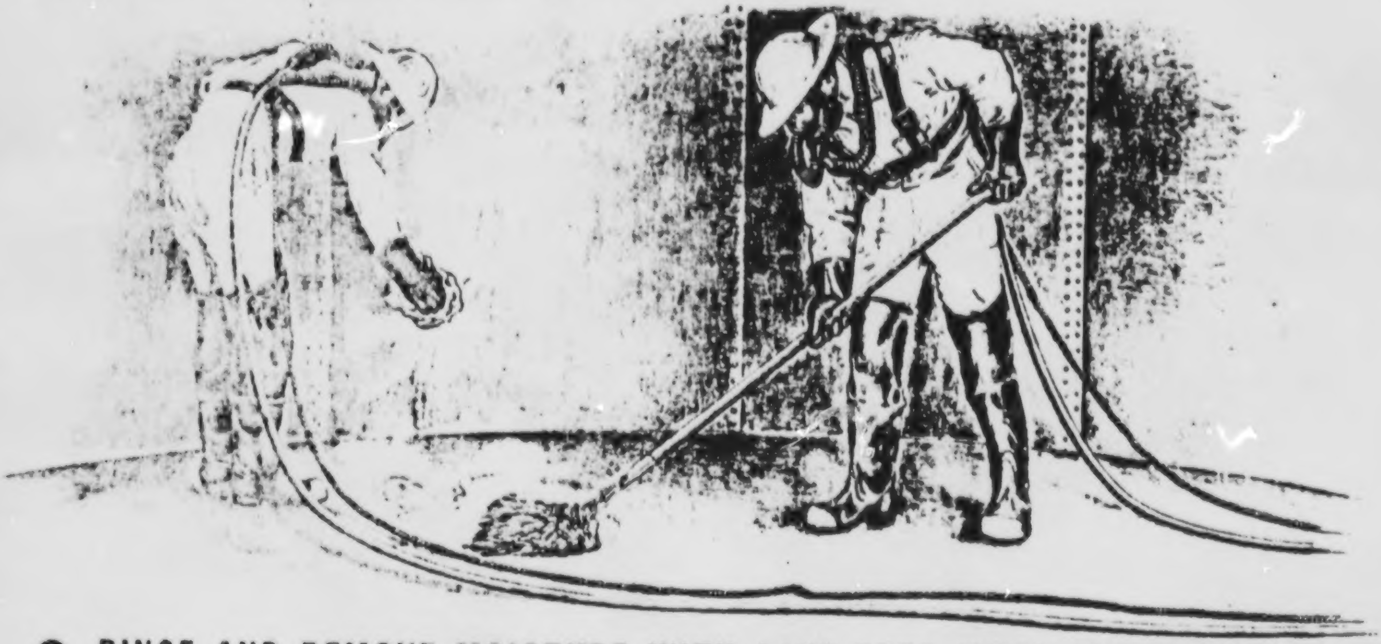
● REMOVE REMAINING SLUDGE, RUST, SCALE, AND DEPOSITS WITH SCRAPERS OR WIRE BRUSHES.



WALK WITH CARE, REST PERIODICALLY, AND INSPECT CLOTHING. WASH GLOVES BEFORE REMOVING. WASH SELF BEFORE EATING OR SMOKING

CLEANING THE STORAGE TANK (CON)

- WIPE DOWN WALLS AND FLOOR WITH SOLVENT.

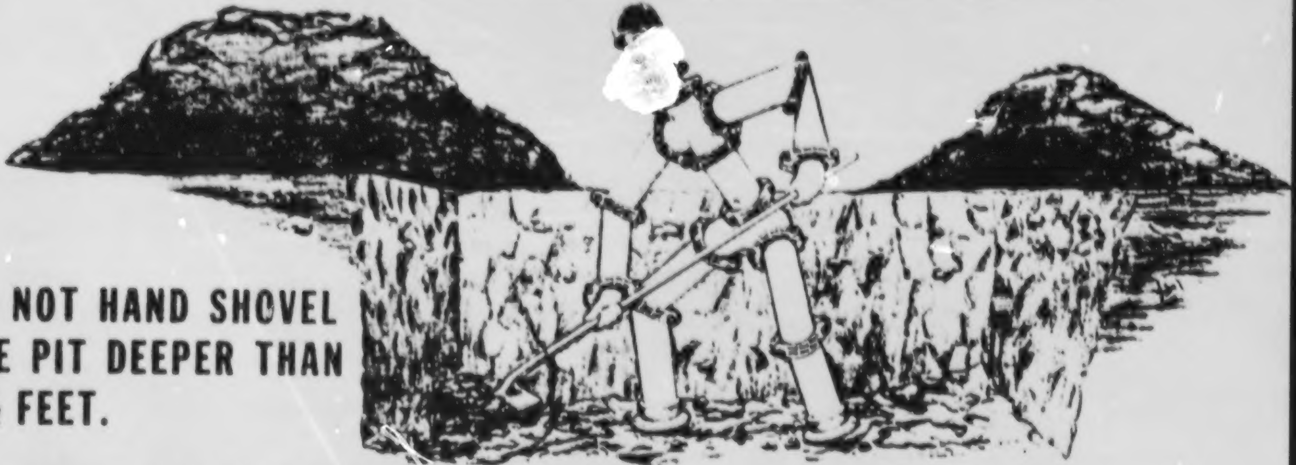


- RINSE AND REMOVE MOISTURE WITH LINT-FREE MOPS AND CLOTHS.
- REPLACE CLEANOUT DOOR. USE A NEW GASKET.
- ENTER CLEANING DATE ON DA FORM 5-34. STENCIL DATE AT A PROMINENT PLACE ON THE TANK.

DISPOSAL OF LEADED SLUDGE

- BURY OR WEATHER

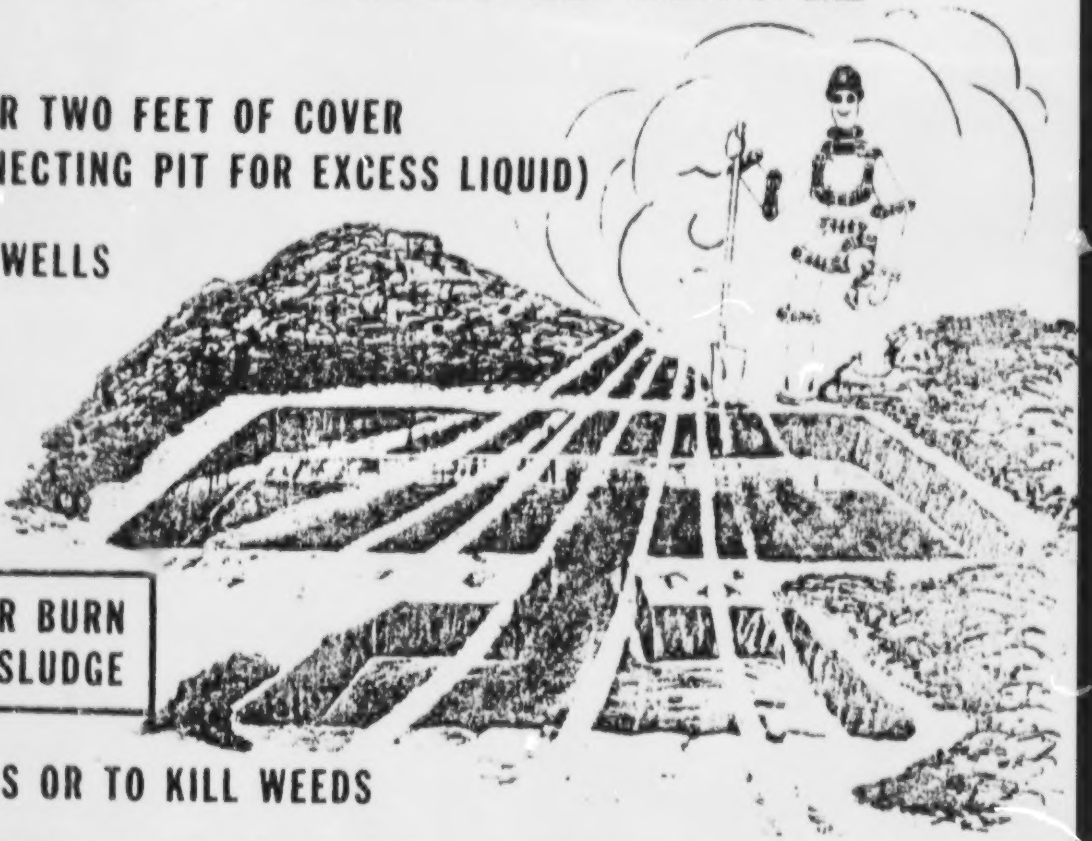
STAY TO WINDWARD SIDE; WEAR PROTECTIVE CLOTHING



- DO NOT HAND SHOVEL THE PIT DEEPER THAN 4½ FEET.
- PIT MUST ALLOW FOR TWO FEET OF COVER. (SEE CHART IN TM 10-1109 FOR SIZE)
- ALLOW WATER TO SOAK INTO GROUND; THEN COVER AND POST THE AREA.

CLEAN ALL EQUIPMENT

DISPOSING OF UNLEADED SLUDGE



- BURY, ALLOW FOR TWO FEET OF COVER
  (DIG CONNECTING PIT FOR EXCESS LIQUID)
- DUMP INTO DRY WELLS
- DUMP AT SEA
- EVAPORATE
  AND BURN

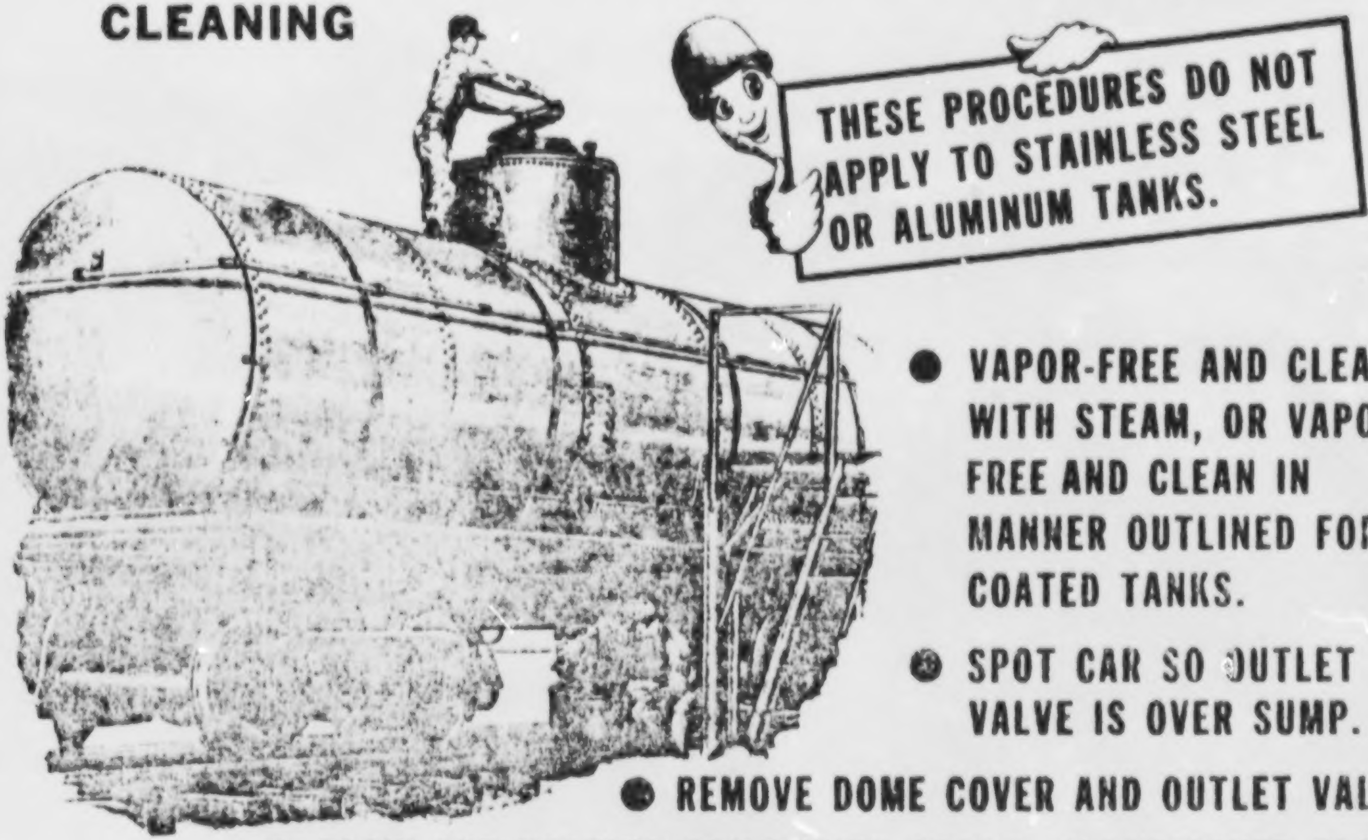
CAUTION: NEVER BURN LEADED SLUDGE

- USE TO OIL ROADS OR TO KILL WEEDS

CLEAN ALL EQUIPMENT

UNCOATED TANK CARS & TANK TRUCKS

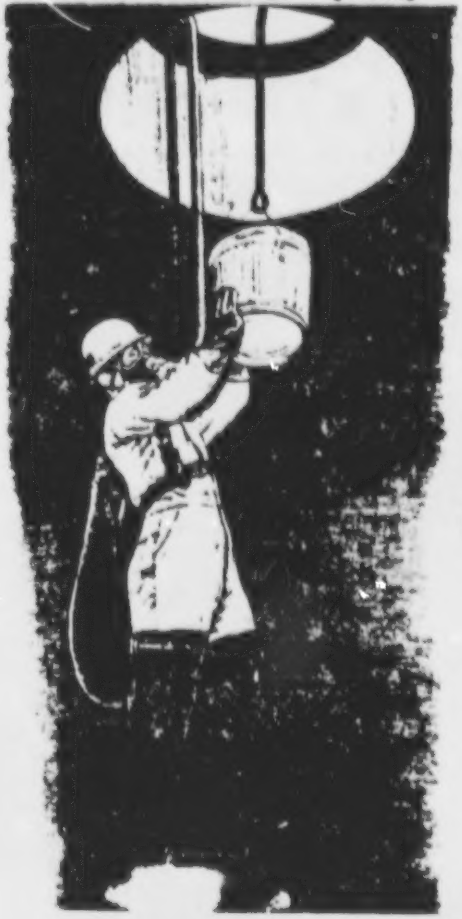
CLEANING


THESE PROCEDURES DO NOT
APPLY TO STAINLESS STEEL
OR ALUMINUM TANKS.

- VAPOR-FREE AND CLEAN WITH STEAM, OR VAPOR-FREE AND CLEAN IN MANNER OUTLINED FOR COATED TANKS.
- SPOT CAR SO OUTLET VALVE IS OVER SUMP.
- REMOVE DOME COVER AND OUTLET VALVE.
- BLOW OUT HEATING COILS WITH STEAM, PLACE COVER PLATE ON DOME, AND INSERT NOZZLE.

UNCOATED TANK CARS & TANK TRUCKS

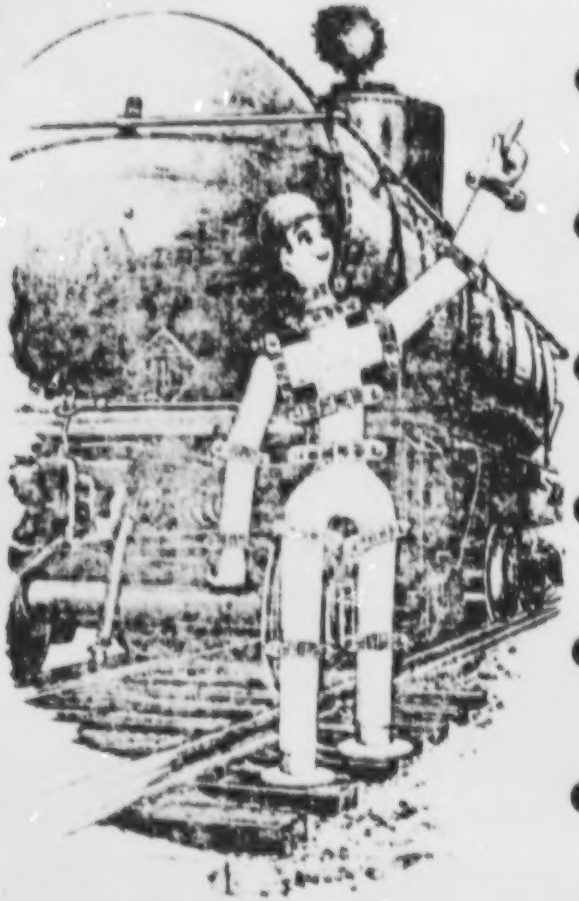
CLEANING (CON)



- BOND NOZZLE INSIDE THE DOME AND GROUND THE TANK SHELL.
- APPLY STEAM FOR ONE HOUR OR LONGER UNTIL TANK IS VAPOR-FREE.
- DETERMINE NECESSITY OF REMOVING SLUDGE AND RESIDUE MANUALLY.
- REMOVE SLUDGE IN BUCKETS 2/3 FULL THROUGH THE DOME, OR SCRAPE AND BRUSH THROUGH THE OUTLET.
- **CAUTION:** WEAR TANK-CLEANING EQUIPMENT AND CLOTHING.

UNCOATED TANK CARS & TANK TRUCKS

CLEANING (CON)

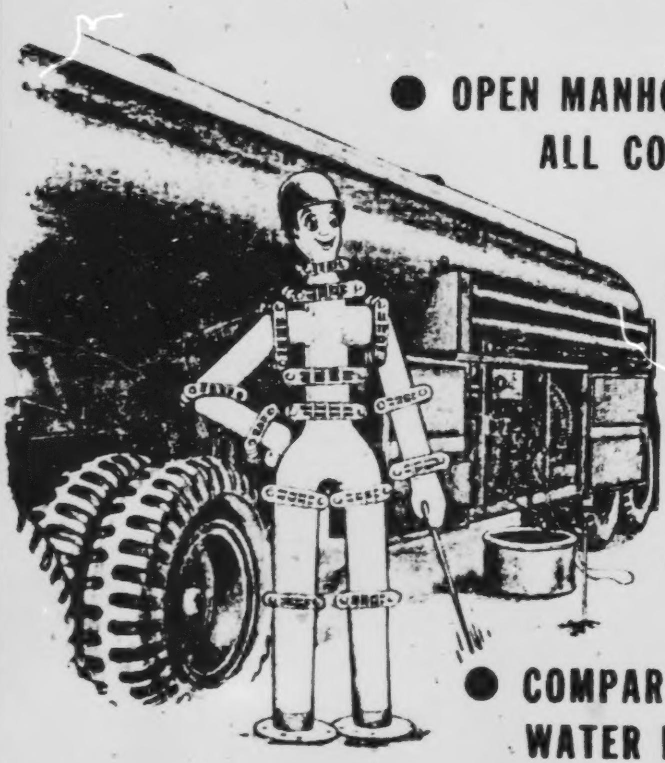


- REPLACE COVER PLATE, INSERT NOZZLE AT ANGLE, AND TURN ON STEAM.
- PLACE SIPHON HOSE IN SOLVENT (CONTAINER UNDER OUTLET).
- ROTATE NOZZLE WHILE SPRAYING DOME. (15 TO 20 MINUTES)
- LOWER NOZZLE AND SPRAY SHELL. ESTIMATE TIME BY AMOUNT OF REMAINING SLUDGE.
- SHIFT SIPHON HOSE TO CLEAR WATER AND SPRAY; THEN DRY DOME AND SHELL.
- DISPOSE OF THE SLUDGE.

COATED TANK VEHICLES & TANK CARS

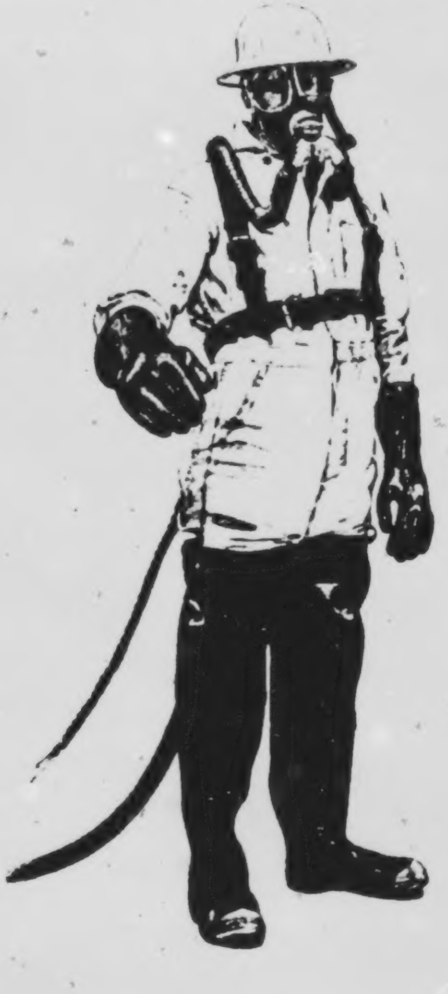
VAPOR-FREEING

- GROUND VEHICLE AND BOND TANK SHELL TO RECEPTACLE.



- OPEN MANHOLE COVERS. DRAIN COMPARTMENTS AND ALL CONNECTING LINES.
- LEAVE ALL VALVES OPEN.
- BOND AIR MOVER TO MANHOLES, VAPOR-FREE COMPARTMENTS, AND TEST PERIODICALLY.
- COMPARTMENTS MAY ALSO BE VAPOR-FREED BY WATER DISPLACEMENT.

COATED TANK VEHICLES & TANK CARS

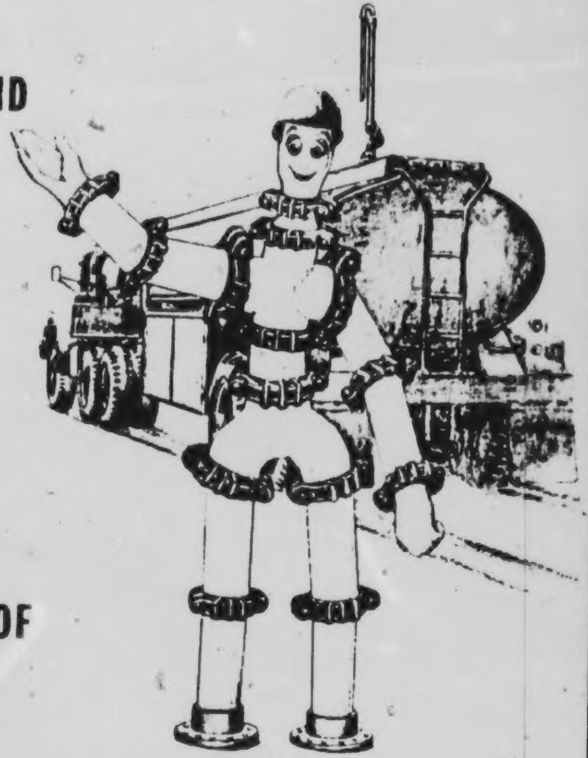


CLEANING

- CAUTION: ALWAYS WEAR RESPIRATOR AND PROTECTIVE CLOTHING IN TANK COMPARTMENTS.
- INSPECT TO DETERMINE DEGREE OF CLEANING NEEDED.
- USE BRUSHES, SCRAPERS, AND SOLVENT.
- WIPE WITH LINT-FREE CLOTHS TO REMOVE SOLVENT.

COATED TANK VEHICLES & TANK CARS

CLEANING (CON)



- FLUSH ALL VALVES, PIPING, MANIFOLD, AND PUMP WITH SOLVENT.
- DISASSEMBLE FILTER/SEPARATOR, WIPE OUT, AND INSTALL NEW CARTRIDGES.
- DISASSEMBLE METER AND WIPE OUT.
- REMOVE STRAINER SCREENS, CLEAN THEM, AND WIPE OUT STRAINER BODY.
- CLOSE ALL VALVES. PUT IN 100 GALLONS OF FUEL TO BE CARRIED, AND CIRCULATE IT THROUGH THE ENTIRE SYSTEM. DISPOSE OF THE FUEL.

SUMMARY

You should be familiar now with what tank maintenance is all about. Be sure you know how to operate and read the explosimeter. If you have any questions about any part of this program please ask an instructor to clear it up. DM 10-20 is the reference you will need to study if you do get assigned to a tank cleaning operation.

Return all the equipment to it's proper storage place then return to the control deak and see the film on tank maintenance. After seeing this film you'll be ready for your next program.

POL

ON THE MOVE

QMS 300.512PT
PS-D-10-PFS

WATERFRONT OPERATIONS

PROPONENT DEPARTMENT: Petroleum and Field Services

April 1977

707

OBJECTIVES:

As a result of this instruction, and provided with a Marine terminal and facilities, the student will be able to:

1. Connect bonding cable from shore to ship and close the grounding switch.
2. Board the ship and gage, sample, all cargo tanks, take before and after readings.
3. Couple cargo hose from shore to ship.
4. Position fire-fighting equipment.
5. Make pre-operations checks to prevent oil spills.
6. Discharge cargo from ship to base terminal.
7. Unload the ship using shore-based facilities.
8. Fill out tanker discharge report DD 250-1.
9. Issue a dry tank certificate.
10. Name three ways to clean up oil spills.

As prescribed in TM's 5-343, 10-1118 and MIL HDBK 201.

730

LESSON OUTLINE

a. Description and use of tank vessels

- (1) General
- (2) Definitions
  - (a) Stern
  - (b) Engine room
  - (c) Pump rooms
  - (d) Starboard
  - (e) Port

b. Types of Tankers

- (1) T-1 tanker
  - (a) General
  - (b) Capacity
  - (c) Pumping system
  - (d) Discharge capacity
  - (e) Cost of operation

709

(2) T-2 tanker

(a) General

(b) Capacity

(c) Pumping system

(d) Discharge capacity

(e) Cost of operation

(3) T-5 tanker

(a) General

(b) Capacity

(c) Pumping system

(d) Discharge capacity

(e) Cost of operation

(4) Super tankers

  (a) General

  (b) Capacity

  (c) Pumping system

  (d) Discharge rate

(5) Jumbo tankers

  (a) General

  (b) Capacity

c. Types of barges

(1) Dumb

(2) Motorized

(3) General

d. Vessel loading and unloading

(1) Marine docks

(2) Jerry and marine dock

(3) Tanker mooring and submarine pipeline

(4) Pontoon causeway

(5) Floating lines

(6) Booster pump stations

e. Procedures prior to arrival of tankers

(1) Preliminary actions

(2) INspection

(3) Heated cargo

f. Tanker unloading procedures

(1) Before unloading begins

(2) Connecting hose procedures

(3) Actual unloading operations

(4) Follow-up procedures to unloading operations

g. Tanker loading procedures

(1) Bonding and grounding

(2) Deballasting

(3) Inspection

(4) Load lines

(5) Follow-up procedures to loading tanker vessels

h. Fire and Safety precautions

i. Ecology and oil spills

(1) Causes

(a) Natural

(b) Human error

(c) Nechanical

(2) Examples

(3) Oil spills

(4) Cleaning up contaminated areas

(5) Risks of contamination

(6) Pipeline operations

(7) Clean-up operations
    (a) Chemicals

    (b) Air bubbles

    (c) Sinkants

    (d) Sorbents

    (e) Mechanical equipment

    (f) Burning

(8) Disposal of recovered and waste oil

(9) Sludge disposal

(10) Three techniques for dewatering are used

(a)

(b)

(c)

(11) On shore methods of disposal of polluted soil can be divided into the categories that follow:

(12) Federal water quality improvement act of 1970.

(13) Spills

j. Review and summary

The following is an example of message supplying information as to the Tanker Arrival Schedule. This information is important to planning operations.

TANKER ARRIVAL SCHEDULE

Cargo Nr., vessel, cargo, destination, ETA: C-124 Cossatot, 50 GR115, 13GR 115 ADAK 16 Nov; 16 GR 115 Kodiak 19 Nov; 21 GR 115, Haines 21 Nov; 30 Mogas, 3 Mogas ADAK 16 Nov; 3 Mogas Kodiak 19 Nov; 24 Mogas, Haines 21 Nov; 50 DSIMAR, 35 DSIMAR ADAK 16 Nov; 15 DSIMAR Kodiak 21 Nov. C-125 Cossatot, 30 Mogas, 10 Mogas Haines 1 Dec; 20 Mogas Whittier 3 Dec; 100 LPD, 50 LPD Haines 1 Dec; SOLPD Whittier 3 Dec. C-137 TBN, 50 JP-4, 30 Mogas, 50 LPD Haines 27 Dec.

06/0256z Nov RJKDAG

FOR TRAINING PURPOSES ONLY

The following is an example of another form as to how the Tank Arrival Schedule may be received.

DEPARTMENT OF THE NAVY
MILITARY SEA TRANSPORTATION SERVICE OFFICE
ANCHORAGE, ALASKA

10 December 1966

TANKER FORECAST

CARGO				
C-127	MILLICOMA	2 MOGAS - 8 DFM	Kodiak	11 Dec
		26 MOGAS - 50 DFA	Haines	14 Dec
C-212	COWANESQUE	50 AVGAS - 80 JP-4	Haines	29 Dec
C-200	MILLICOMA	50 DFA - 20 MOGAS	Haines	23 Jan
		30 DFA - 30 MOGAS	Whittier	26 Jan
C-213	COWANESQUE	20 AVGAS - 40DFM-4 MOGAS	Adak	1 Feb
		20 AVGAS-10DFM-4 MOGAS	Kodiak	5 Feb
		10 AVGAS - 22 MOGAS	Haines	8 Feb
B-95	X	30 NSFO	Whittier	25 Feb
		80 NSFO	Kodiak	27 Feb
C-249	X	80 JP-4-50 AVGAS	Haines	5 Mar
C-274	X	50 AVGAS-50 JP-4-30 MOGAS	Whittier	5 Apr
C-275	X	10 AVGAS-3 MOGAS-40DFM	Adak	10 Apr
		10 AVGAS-2 MOGAS-10DFM	Kodiak	14 Apr
		30 AVGAS-25MOGAS	Haines	17 Apr

The following is an example of a breakout of a message for one's own quick reference, and planning purposes.

TANKER SCHEDULE

DATE

ETA DATE	CARGO	SHIP	PORT	115	JP-4	91C	DSL MAR	DM-A	NSFO
16 Nov	C-124	Cossatot	ADAK	13	-	3	35	-	-
19 Nov	"	"	Kodiak	16	-	3	15	-	-
21 Nov	"	"	Haines	21	-	24	-	-	-
TOTALS	-	-	-	50	-	30	50	-	-
1 Dec	C-125	Cossatot	Haines	-	-	10	-	50	-
3 Dec	"	"	Whittier	-	-	20	-	50	-
TOTALS	-	-	-	-	-	30	-	100	-
27 Dec	137	TBN	ND	-	-	30	-	50	-

TANKERS
T2-SE-A1 EQUIVALENTS*
(AS OF END OF YEAR)

1968 Rank	1958 Rank	Flag of Registry	(T-2 Equivalents)			Deadweight Tonnage	Number of Vessels	
			1966	1958	1968		1958	1968
1	1	Liberia	1,472	700	1860	28,512,700	417	6[illegible]
2	3	Norway	998	502	1174	17,976,800	476	421
3	4	United Kingdom	787	493	971	15,072,700	556	420
4	10	Japan	582	103	884	13,502,500	88	232
5	2	United States	566	530	575	8,655,700	474	380
6	5	Panama	264	232	314	4,802,700	195	152
7	6	France	261	150	314	4,759,800	122	130
8	11	Italy	219	133	275	4,144,200	128	127
9	7	USSR	243	29	273	4,300,900	58	277
10	8	Sweden	206	130	236	3,577,400	199	87
11	12	Greece	189	19	211	3,406,900	25	142
12	9	Netherlands	166	109	203	3,164,800	124	91
		All Other	--	--	912		--	595
		Total World	6641	3403	8202		3146	3748

*A nominal T-2 ship is defined as a 16,765 D.W.T., 14.5 knot vessel.

**Includes U. S. S. R.

Year Ending 31 Dec 1968.

Average Deadweight Tonnage and Speed

1968	1958
33,000 DWT	18,000 DWT
15.8 Knots	14.6 Knots

TANKER ACTIVITY REPORT

1. Name of Ship: ____________________
2. Company: ____________________
3. Name of Master: ____________________
4. Name of 1st Officer: ____________________
5. Type of Product: ____________________
6. Quantity per B/Lading: __________ net bbls @ 60°F.
7. Ships ullage after loading: __________ net bbls @ 60°F.
8. Ships ullage before discharging: __________ net bbls @ 60°F.
9. Amount of water: __________ bbls.
10. Short/Over before discharging: ____________________
11. Date and time ship arrived in port: ____________________
12. Date and time ship arrived at dock: ____________________
13. Time mooring completed: ____________________
14. Time grounding cable connected: ____________________
15. Time hoses connected: ____________________
16. Time ullage taking started: ____________________
17. Time ullage taking finished: ____________________
18. Remarks (Yes) (No) use reverse: ____________________
19. Time laboratory crew started: ____________________
20. Time finished: ____________________
21. Sea valve seals (Describe by number). ____________________
22. Date and time pumping commenced: ____________________
23. Date and time pumping ceased: ____________________
24. Date and time of Dry Tank Inspection: ____________________
25. Initials of Inspector: ____________________

26. Remarks: (Yes) (No) use reverse side:

27. Time hoses disconnected: ______________________________

28. Time grounding cable disconnected: ______________________

29. Time sea valves broken: ______________________________

30. Incidents and Delays: (Yes) (No) ______________________

31. Pass numbers of men attending ship:

Supervisors: ____ ____ ____ ____

Lab Crew: ____ ____ ____ ____

Electricians: ____ ____ ____ ____

Dock Crew:

1st Shift: ____ ____ ____ ____

2nd Shift: ____ ____ ____ ____

3rd Shift: ____ ____ ____ ____

4th Shift: ____ ____ ____ ____

TANKER/BARGE MATERIAL INSPECTION AND RECEIVING REPORT	1. TANKER/BARGE ☐ LOADING REPORT ☒ DISCHARGE REPORT	2. INSPECTION OFFICE Dept of Navy Washington D.C. 20390	3. REPORT NUMBER 68-3

4. AGENCY PLACING ORDER ON SHIPPER, CITY, STATE AND/OR LOCAL ADDRESS (Loading) U.S. Navy Fuel Supply Office, Washington D.C. 20390	5. DEPARTMENT Navy	6. PRIME CONTRACT OR P.O. NUMBER DSA-6-349
7. NAME OF PRIME CONTRACTOR, CITY, STATE AND/OR LOCAL ADDRESS (Loading) Shell Caribbean Petroleum Co., New York, N.Y. 11230		8. STORAGE CONTRACT NA
9. TERMINAL OR REFINERY SHIPPED FROM, CITY, STATE AND/OR LOCAL ADDRESS Compania Shell De Venezuela ltd pta cardon Venezuela		10. ORDER NUMBER ON SUPPLIER NA
11. SHIPPED TO: (Receiving Activity, City, State and/or Local Address) U.S. Navy Fuel Supply Office DaNang South Vietnam, FPO San Francisco, Calif, 96620		12. B/L NUMBER NA 13. REQN. OR REQUEST NUMBER NA 14. CARGO NUMBER 68-123

15. VESSEL S.S. Neversail	16. DRAFT ARRIVAL FORE 29'11" AFT 29'11"	17. DRAFT SAILING FORE 10'10" AFT 17' 4"
18. PREVIOUS TWO CARGOES FIRST NSFO LAST NSFO	19. PRIOR INSPECTION U.S. Navy Insmat, Concord, Calif, 96620	
20. CONDITION OF SHORE PIPELINE Full at start and finish	21. APPROPRIATION (Loading) NA	22. CONTRACT ITEM NUMBER NA
23. PRODUCT Fuel Oil Burner, grade Navy Special	24. SPECIFICATIONS Mil-F-859 and Amendment 2	

25. STATEMENT OF QUANTITY	LOADED	DISCHARGED	LOSS/GAIN	PER CENT
BARRELS (42 Gals) (Net)	132 242	131 930	312	
GALLONS (Net)	5 554 164	'5 541 060	13104	.002
TONS (Long)	19 186.07			

26. STATEMENT OF QUALITY

TESTS	SPECIFICATION LIMITS	TEST RESULTS
GRAVITY, °A.P.I. @ 60°	11.5 Min	20.8
FLASH POINT, Closed Cup, °F	150 Min	200
VISCOSITY, SSU @ 122°F	225 Max	216.5
WATER & SEDIMENT By Centrifuge	0.5 Max	0.1

All Times Zulu

27. TIME STATEMENT	DATE	TIME
NOTICE OF READINESS TO LOAD DISCHARGE	24 Jul 67	0930
VESSEL ARRIVED IN ROADS	24 Jul 67	0600
MOORED ALONGSIDE	24 Jul 67	0945
STARTED BALLAST DISCHARGE		
FINISHED BALLAST DISCHARGE		
INSPECTED AND READY TO LOAD DISCHARGE	24 Jul 67	0955
CARGO HOSES CONNECTED	24 Jul 67	1120
COMMENCED LOADING DISCHARGE	24 Jul 67	1130
STOPPED LOADING DISCHARGING	25 Jul 67	0610
RESUMED LOADING DISCHARGING		
FINISHED LOADING DISCHARGING		
CARGO HOSES REMOVED	25 Jul 67	0730
VESSEL RELEASED BY INSPECTOR	25 Jul 67	0740
COMMENCED BUNKERING		
FINISHED BUNKERING		
VESSEL LEFT BERTH (Actual/Estimated)	25 Jul 67	0810

28. REMARKS (Note in detail cause of delays such as repairs, breakdown, slow operation, stoppages, etc.)

Seal Numbers and Location
150271-PSS
150272-SSS
150273-P OVBD DIS
150274-S OVBD DIS
1) Delays, cause, responsible party
2) Abnormal differences of ullage

U.S. Navy FSO DaNang RVN

29. COMPANY OR RECEIVING TERMINAL
Thomas A. Ross USN Term Opns Off
(Signature)

30. I CERTIFY THAT THE CARGO WAS INSPECTED, ACCEPTED AND LOADED/DISCHARGED AS INDICATED HEREON.
24 Jul 67
(Date)
LT Robert L Dainton 525 Base Lab
(Signature of Authorized Government Representative)

31. I HEREBY CERTIFY THAT THIS TIME STATEMENT IS CORRECT.
Christian Tigges First Officer
(Master or Agent)

DD FORM 1 MAR 66 250-1 REPLACES DD FORM 250-1, 1 JUL 65, WHICH MAY BE USED.

TANKER/BARGE

☒ LOADING REPORT* ☐ DISCHARGE REPORT*

OFFICE ADMINISTERING CONTRACT INSMAT ARUBA N.A.	INSPECTION OFFICE INSMAT ARUBA N.A.	REPORT NO. 68-1
AGENCY PLACING ORDER ON SHIPPER, CITY, STATE AND/OR LOCAL ADDRESS (Loading) U.S. Navy Fuel Supply Office Washington D.C. 20390	DEPARTMENT U.S. Navy	PRIME CONTRACT OR P.O. NO. DSA-6-349
NAME OF PRIME CONTRACTOR, CITY, STATE AND/OR LOCAL ADDRESS (Loading) Shell Caribbean Petroleum Co. New York N.Y. 11230		STORAGE CONTRACT NA
TERMINAL OR REFINERY SHIPPED FROM, CITY, STATE AND/OR LOCAL ADDRESS Companía Shell De Venezuela Ltd Pta Cardon Venezuela		ORDER NO. OR SUPPLIER 68-557
SHIPPED TO (Receiving Activity, City, State and/or Local Address) U.S. Navy Fuel Supply Office Danang, South Vietnam FPO San Francisco California 96620		B/L NUMBER NA
		REQN OR REQUEST NO. NA
		CARGO NO. 68-123
VESSEL S S Neversail	DRAFT ARRIVAL FORE 11' 10" AFT 18' 4"	DRAFT SAILING FORE 29" 10" AFT 32" 0"
PREVIOUS TWO CARGOES LAST NSFO NEXT LAST NSFO	INSPECTION OFFICE [redacted] CHIEF OF NAVAL MATERIAL NAVAL SUPPLY SYSTEM COMMAND	
CONDITION OF SHORE PIPELINE Full at start and finish	APPROPRIATION (Loading) 17 X 4911 2320 NSF	CONTRACT ITEM NO. 2 (A)
PRODUCT* Fuel Oil Burner, Grade Navy Special	SPECIFICATIONS Mil-F- 859 and Amendment 2	

STATEMENT OF QUANTITY	LOADED	DISCHARGED	LOSS/GAIN	PER CENT
BARRELS (42 Gals.) (Net)	132 242			
GALLONS (Net)	5554 164			
TONS (Long)	19 186.07			

STATEMENT OF QUALITY

TESTS	SPECIFICATION LIMITS		TEST RESULTS	
SHORE TANKS -			D 2/3	D 2/4
NET BARRELS -			29,365	102,877
Gravity, °A.P.I.	11.5	Min.	19.0	21.3
Flash, closed cup, °F	150	Min.	254	270
Viscosity,. SSU @ 122°F	225	Max.	215	208

SAMPLE

All Times Zulu

TIME STATEMENT	DATE	TIME
NOTICE OF READINESS TO LOAD [redacted]	23 June 67	2330
VESSEL ARRIVED IN ROADS	23 June 67	2330
MOORED ALONGSIDE	24 June 67	0100
STARTED BALLAST DISCHARGE		
FINISHED BALLAST DISCHARGE		
INSPECTED AND READY TO LOAD [redacted]	24 June 67	0500
CARGO HOSES CONNECTED	24 June 67	0530
COMMENCED LOADING [redacted]	24 June 67	0535
STOPPED LOADING [redacted]	25 June 67	1900
RESUMED LOADING DISCHARGING		
FINISHED LOADING DISCHARGING		
CARGO HOSES REMOVED	25 June 67	2000
VESSEL RELEASED BY INSPECTOR	25 June 67	2050
COMMENCED BUNKERING		
FINISHED BUNKERING		
VESSEL LEFT BERTH [redacted] ANCHORAGE	25 June 67	2310

REMARKS (Note in detail cause of delays such as repairs, breakdowns, slow operation, stoppages, etc.)

Seal Numbers and Location

150271	PSS
150272	SSS
150273	P OVBD DIS
150274	S OVBD DIS

1) All delays, cause, responsible party
2) Details of product losses
3) Each consignee and amount
4) FY (Year) Map for all Map shipments

Compania Shell De Venezuela, Ltd

COMPANY OR RECEIVING ACTIVITY
Sancho Panza
Sancho Panza, Ch Term Opns
(Signature)

I CERTIFY THAT THE CARGO WAS INSPECTED, ACCEPTED AND LOADED/DISCHARGED AS INDICATED HEREON.

Darious E Kirby
9 July 67 — Darious E Kirby, INSMAT 109
(Date) (Signature of Authorized Government Representative)

I HEREBY CERTIFY THAT THIS TIME STATEMENT IS CORRECT.

C. Tigges
Christian Tigges, First Officer
(Master or Agent)

DD FORM 1 JUL 66 250-1 REPLACES DD FORM 250-1, 1 MAY 57, WHICH WILL BE USED.

*CHECK APPLICABLE BLOCK TO INDICATE WHETHER LOADING OR DISCHARGE REPORT

SAMPLE

723

HOSE RECORD-63 Dept.

____ CODE ______________

SHEET ______________

Mfr____________ Req____________ Date__________ Rec'd________ Fld Weld__________

In Service________ Size______ in Length__________ ft MWP__________ lbs Bore __________

Notes: ____

Date	Ship/Barge	Barrels	Cargo	-Hours-		Total	Hyd Test	Notes
				Dis	Ld			

746

TERMINAL REGULATIONS
TANK VESSELS-LOADING AND UNLOADING

The U. S. Army reserves the right to impose upon any vessel using its docks for any purpose, the regulations stated below covering safe practices for handling petroleum products and prevention of fire hazards.

Master of said vessel hereby agrees to comply with these regulations and to permit properly assigned terminal personnel to make inspection of his vessel at any time to check compliance with these regulations.

1. Shut down loading or discharging of vessel if vessel personnel violate any of these rules at any time or refuse to correct unsatisfactory conditions promptly.

The terminal superindentendent has the authority to refuse to load or unload any tank vessel which he considers to be unsafe because of condition, equipment, or conduct of crew. The terminal shall take necessary steps to insure that fire regulations are being complied with and that unsafe practices are not existent while tank vessels are tied up to the terminal's docks.

2. Matches - the only matches allowed aboard ship are safety matches. Cigarette lighters are allowed only in authorized smoking areas.

3. Smoking Lamp - the smoking lamp is out during cargo transfer, and is never lighted on the weather decks.

4. Ullage screens MUST remain in place at ALL TIMES during cargo transfer, except for the few seconds required to gage the tanks.

5. Fire-Fighting Equipment must be kept ready for instant use.

6. Mooring - A secure mooring must be maintained when fuel hose is connected in order to prevent undue strain on the hose. Single lines should be used for mooring; lines should not be doubled. Lines should be so secured that each line may be slacked off or taken in readily as the ship changes draft during loading and/or discharge. Do not moor with steel cable except in emergencies.

7. Hatches and Ports - all hatches leading into the cargo tanks MUST be closed and dogged during cargo handling. All hatches and ports throughout the vessel must also be closed and dogged during transfer operations.

TERMINAL REGULATIONS
TANK VESSELS - LOADING AND UNLOADING
CONTINUED

8. Warnings displayed - during cargo transfer, display a red flag (Bravo) by day and an electric red light by night. "NO OPEN LIGHTS" and "NO SMOKING" sings shall be prominently displayed.

9. Static bonding cable must be connected before connecting hoses. Connection must be made first on vessel before switch is closed on dock. Disconnect static bonding cable after hoses are disconnected.

10. No general cargo will be loaded in the area during the transfer of flammable petroleum products.

11. Scuppers on the tank deck will be plugged during operations.

12. STOP TRANSFER OPERATIONS IMMEDIATELY if any of the following conditions exist:

   a. Electrical storm.

   b. High wind.

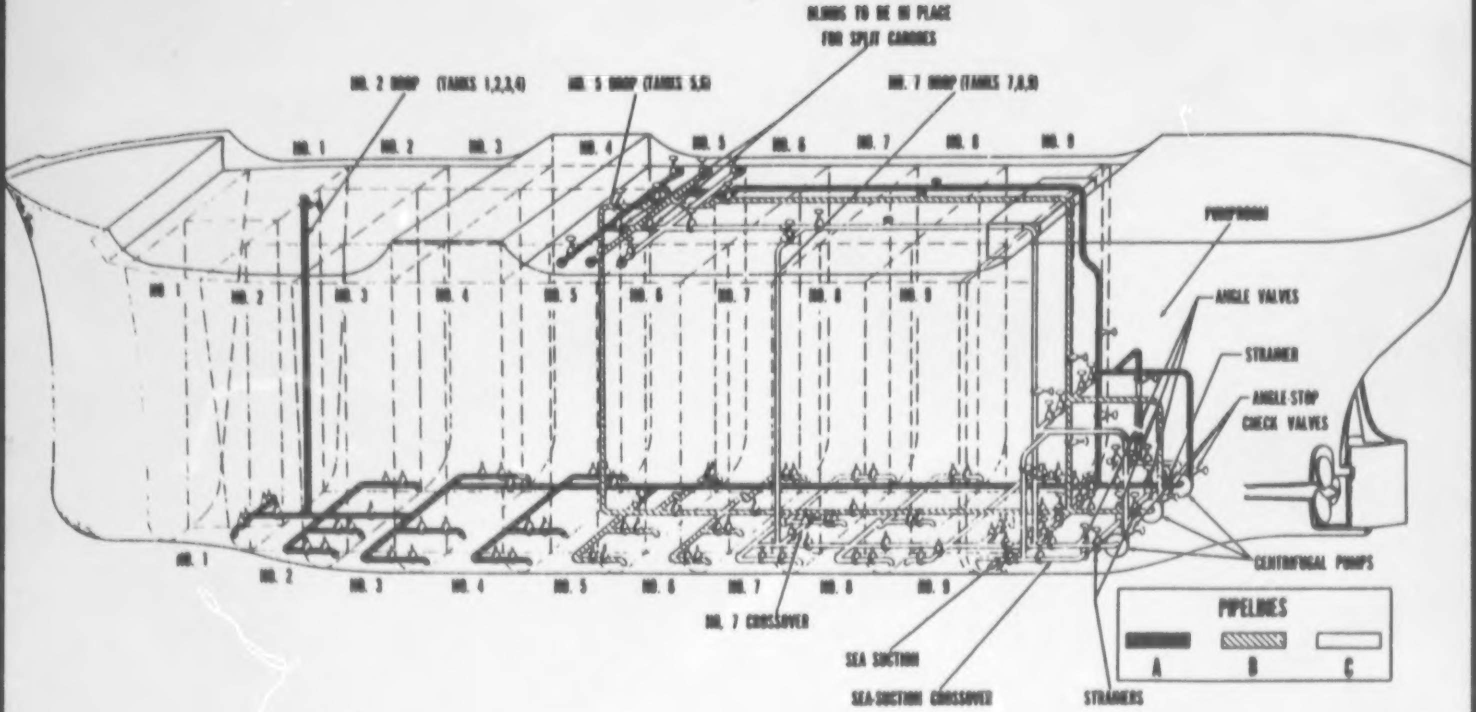
   c. Cargo spill.

   d. Towboat alongside.

   e. A ship passing close aboard.

   f. DURING ANY EMERGENCY.

13. Allow no unauthorized visitors on board during cargo transfer, and keep the tank deck clear of personnel not engaged in cargo handling.


BLINDS TO BE IN PLACE FOR SPLIT CARGOES
NO. 2 DROP (TANKS 1,2,3,4)
NO. 5 DROP (TANKS 5,6)
NO. 7 DROP (TANKS 7,8,9)
NO. 1
NO. 2
NO. 3
NO. 4
NO. 5
NO. 6
NO. 7
NO. 8
NO. 9
PUMPROOM
NO. 1
NO. 2
NO. 3
NO. 4
NO. 5
NO. 6
NO. 7
NO. 8
NO. 9
ANGLE VALVES
STRAINER
ANGLE-STOP CHECK VALVES
CENTRIFUGAL PUMPS
NO. 1
NO. 2
NO. 3
NO. 4
NO. 5
NO. 6
NO. 7
NO. 8
NO. 9
NO. 7 CROSSOVER
SEA SUCTION
SEA-SUCTION CROSSOVER
STRAINERS
PIPELINES
A
B
C

NIPUB 358(SUP)

SUPPLEMENTAL MATERIAL

PETROLEUM SUPPLY SPECIALIST

MOS 76W10

U.S. ARMY QUARTERMASTER SCHOOL
FORT LEE, VIRGINIA

SUPPLY TRAINING CENTER OF THE ARMY SCHOOL SYSTEM
PROPONENT DEPARTMENT: Enlisted Supply
ATSM-DT-TM-OT-ET
MAY 1978
REPRINT DATE JUNE 1979

Army-Fort Lee, Va. [illegible]850-79-330-5

728

1

EQUIPMENT INSPECTION AND MAINTENANCE WORKSHEET

For use of this form, see TM 38-750; the proponent agency is the Office of the Deputy Chief of Staff for Logistics.

1. ORGANIZATION				2. NOMENCLATURE AND MODEL		
ISTRATION/SERIAL/FSN	4a. MILES	b. HOURS	c. ROUNDS FIRED	d. HOT STARTS	5. DATE	6. TYPE INSPECTION

7. APPLICABLE REFERENCE			
TM NUMBER	TM DATE	TM NUMBER	TM DATE

INSTRUCTIONS - Perform each check listed in the TM applicable to the inspection performed. Following the sequence listed in pertinent TM, complete form as follows:

COLUMN a - Enter TM item number.

COLUMN b - Enter the applicable condition status symbol.

COLUMN c - Enter deficiencies and shortcomings.

COLUMN d - Show corrective action for deficiency or shortcoming listed in Column c.

COLUMN e - Individual ascertaining completed corrective action initial in this column.

ALL INSPECTIONS AND EQUIPMENT CONDITIONS RECORDED ON THIS FORM HAVE BEEN DETERMINED IN ACCORDANCE WITH DIAGNOSTIC PROCEDURES AND STANDARDS IN THE TM CITED HEREON.

8a. SIGNATURE *(Person(s) performing inspection)*	8b. TIME	9a. SIGNATURE *(Maintenance Supervisor)*	9b. TIME	10. MANHOURS REQUIRED

TM ITEM NO. a	STATUS b	DEFICIENCIES AND SHORTCOMINGS c	CORRECTIVE ACTION d	INITIAL WHEN CORRECTED e

SAMPLE

DA FORM 1 JAN 64 2404

PS-A-3-PFS
QMS 300.656
A-3

EXAMINATION

VISUAL CONTAMINATION & EXAMINATION

"The work submitted herein is my own work; I have neither given nor received unauthorized assistance; I have seen no evidence of cheating in any form throughout this examination, other than that which I have or will report to proper authority."

____
Signature

		VALUE	SCORE
Read instructions carefully. Work at your own pace.			
1. Answer the following questions.			
a. When performing a visual examination what are the three things you must report?			
________________		4	____
________________		4	____
________________		4	____
b. What is the color of each of the following fuels?			
(1) AVGAS (Grade 100LL)	____________	5	____
(2) MOGAS (Combat)	____________	5	____
(3) JP-4	____________	5	____
(4) Diesel Fuel	____________	5	____
c. What are the four major fuel contaminants?			
________________		4	____
________________		4	____
________________		4	____
________________		4	____

PROPONENT DEPARTMENT: Petroleum & Field Services
November 1976

	VALUE	SCORE
d. By rule of thumb correct the following API's.		
(1) 51.6 @ 76 ______________	5	
(2) 35.8 @ 51 ______________	5	

2. You will now be required to perform a visual examination and API test. Do not write below this line. Take this examination form and give it to the instructor at the examination table.

NOTE TO INSTRUCTOR: Have the student select a sample and observe if he correctly does the following:

	VALUE	SCORE
a. Identify product	5	
b. Identify contamination	5	
c. Use proper procedure		
(1) Shake before pouring	4	
(2) Rinse hydrometer	4	
(3) Break air bubbles	4	
(4) Proper method of inserting hydrometer	4	
d. Read hydrometer	5	
e. Read thermometer	5	
f. Correct API using Table 5	6	

PSS-C2-PEE

QM9 300.664
C.3

50 GPM PUMP

The work submitted herein is my own work; I have neither given nor received unauthorized assistance; I have seen no evidence of cheating in any form throughout this examination, other than that which I have or will report to proper authority."

Signature

PROPONENT DEPARTMENT: Petroleum and Field Services

NOV 76

PSS-C2-PEE

NAME ______________________________

Instructor give student authorization (DA Form 2404).

	VALUE	SCORE
SAFETY CHECK - DID THE STUDENT...		
1. Place CO_2 fire extinguisher in work area	2	____
2. Place "No Smoking" signs in work area	2	____
Ground the pump (procedure)		
3. -ground rod placed in ground (3 ft)	2	____
4. -connect ground cable from ground rod to pump	2	____
BEFORE OPERATIONAL CHECKS - DID THE STUDENT...		
1. Check discharge nozzles and screen	2	____
2. Check discharge hose	2	____
3. Check oil level (add as required)	2	____
4. Check fuel tank and sediment bowl (add as required)	2	____
5. Check oil bath air cleaner (add or change as required)	2	____
6. Check suction hose	2	____
7. Check starter rope	2	____
SET UP - DID THE STUDENT...		
1. Connect suction hose to the pump suction port	2	____
2. Connect suction hose to source of supply	2	____
3. Connect discharge hose to pump discharge port	2	____
4. Connect nozzle to discharge hose	2	____
OPERATION - DID THE STUDENT...		
1. Prime or flood pump	2	____
2. Open source of supply	2	____
3. Starting procedure		
-check the choke	2	____
-open fuel shut off valve	2	____
-position speed control level 1/2 way	2	____
-pull magneto switch down	2	____
-wind starter rope on pulley (clockwise), pull starter rope	2	____
4. After engine start		
-warm pump for 5 to 10 minutes	2	____
5. Bleed off air in hose	2	____
6. Increase engine speed	2	____
7. Fill container to proper fill level	2	____

	VALUE	SCORE
DURING OPERATION - DID THE STUDENT...		
1. Check for noise	2	
2. Check for leak(s)	2	
SHUT DOWN PROCEDURE - DID THE STUDENT...		
1. Idle engine down	2	
2. Allow engine to cool for 3 to 5 minutes at idle	2	
3. Shut off source of supply	2	
4. Disconnect suction hose from source of supply	2	
5. Elevate suction hose and walk into pump	2	
6. Disconnect suction hose and replace dust caps and dust plugs on pump and hoses	2	
7. Push in magneto switch to stop engine	2	
8. Close the fuel shut off valve	2	
9. Disconnect discharge hose and replace dust caps and dust plug	2	
10. Drain discharge hose into container	2	
11. Remove nozzles and replace dust caps and dust plugs	2	
AFTER OPERATION - DID THE STUDENT...		
1. Perform after operational maintenance	2	
2. Check discharge nozzles and screen	2	
3. Check discharge hose	2	
4. Check oil level (add as required)	2	
5. Check fuel tank and sediment bowl (add as required)	2	
6. Check oil bath air cleaner (add or change as required)	2	
7. Check suction hose	2	
8. Check starter rope	2	
9. Complete entries on DA Form 2404	2	
PACK ASSEMBLY AWAY - DID THE STUDENT...		
1. Clean equipment	2	
2. Place equipment in carrying case	2	

Total--100

734

QMS 300.304-1PEE

PRACTICAL EXERCISE

AIRCRAFT REFUELING

PROPONENT DEPARTMENT: Petroleum and Field Services

Nobember 1976

INSTRUCTIONS TO STUDENT

You have already had instruction in the use of the M49C tanker, the M131 tanker, and the FARE System. In this practical exercise you will be familiarized with the ten (10) point hot refueling system and you will use an M49C tanker to fuel and defuel an aircraft. Turn the page and follow your instructions closely.

1. Get a copy of TM 10-1101. Turn to page 142.
2. Read and study closely Section V. (Pages 142 thru 151.)
3. After studying these pages closely go the the Petroleum Training Facility and report to the instructor at the fixed wing aircraft.
4. The instructor will advise you where to fuel and defual the aircraft.
5. Using proper safety and operational techniques learned in tank vehicle operations, carry out the instructions given you.
6. Practice this operation until you are confident of your ability.
7. Review pages 142 thru 151 then advise the instructor when you feel you are ready for your examination.

GOOD LUCK

U. S. ARMY QUARTERMASTER SCHOOL

LESSON PLAN

QMS CODE 300.512

COURSE: PETROLEUM SUPPLY SPECIALIST

ANNEX: TERMINAL OPERATING

INSTRUCTIONAL UNIT: Waterfront Operations (D-10)

TYPE: Conference, Practical Exercise 1, Practical Exercise 2, and Television

TIME ALLOTTED: Eight (8) Hours

CLASSES PRESENTED TO: Enlisted Students

TOOLS, EQUIPMENT AND MATERIAL: QMS 300.076W1, Vol IV

PERSONNEL: Four (4) Instructors

TRAINING AIDS: Vugraphs #55-69, #55-70, #55-72, #55-73, #55-74 #55-75, #55-76, #55-77, #55-82, #55-83, #55-79, #56-100W5, #55-85, #55-86, #55-87, #55-88, #55-89, #55-90, #55-91, #55-92, #1, 2, 3, 4 and 5 and a vugraph machine.

REFERENCES: TM 10-1101, TM 10-1118, TF 10-2855 (FC #64), MF 10-7990 (FC #6)

STUDY ASSIGNMENTS: None

STUDENT UNIFORM AND EQUIPMENT: Duty Uniform, Notebook and Pencil

TROOP REQUIREMENTS: None

TRANSPORTATION REQUIREMENTS: None

PROPONENT DEPARTMENT: Petroleum and Field Services

OCTOBER 1974

THIS LESSON PLAN SUPERSEDES QMS 300.512 DATED AUGUST 1973.

1. INTRODUCTION)Conference, 5 min) (1 Instructor)

a. Objective.

As a result of this instruction, when provided with a marine terminal and facilities, the student will be able to connect bonding cable from shore to ship, and close the grounding switch; board the ship and gage, sample all cargo tanks, before and after readings; couple cargo hose from shore to ship, and make preoperations checks to prevent oil spills; discharge cargo from ship to base terminal; unload the ship using shore base facilities; fill out tanker discharge report Form DD 250-1; issue a dry tank certificate; and name three ways to clean up oil spills; all as prescribed in TM 10-1101, TM 10-1118, (FC 64), MF 10-7990, FC #6.

b. Reasons.

Transportation by water allows us to move very large quantities of products to overseas theaters. Even before proper waterfront facilities can be constructed, products are brought in over the beach from small tankers or barges, to temporary storage on or near the beach. You may be assigned to a Petroleum Unit that operates a water terminal. You knowledge and skill in waterfront operations will be an asset to you in your military career and also in a civilian job placement. Many operations can be affected by how well you apply the knowledge you will gain in this period of instruction.

c. Procedure.

You have already received instructions on tank vehicle operations; now we are moving on to bigger modes of transportation, tanker and barges, tankers, of course, being the biggest of all. In this block of instruction you will be taught all the necessary procedures for loading and unloading tankers and barges, plus all the safety precautions involved. After the classroom instructions, we will move to the Petroleum Training Facility and practice loading and unloading a tanker - the "USS Never-Sail".

2. EXPLANATION (Conference, 110 min, TV 35 min).

a. Description and Use of Tank Vessels.

(1) Designed to deliver large, bulk petroleum cargoes with speed and safety.

(2) Definitions

NOTE: Instructors explain terms.

(a) Stern

(b) Engine Room

(c) Pump Rooms

NOTE: Show vugraph #55-69.

(d) Starboard

(e) Port

b. Types of Tankers.

NOTE: Show vugraph #55-70.

(1) T-1 Tanker

(2) T-2 Tanker

NOTE: Show vugraph #55-70 and explain difference.

(3) T-5 Tanker

NOTE: Show vugraphs #55-72 and #55-73.

(4) Super Tankers

NOTE: Show vugraph #55-74.

(5) Jumboized Tankers

c. Types of Barges.

NOTE: Instructor explain different types.

(1) Barges vary in size and capacity

NOTE: Show vugraph #55-75.

(2) Self-Propelled (Motorized)

(3) Towing Barges (Dumb Barges)

d. Vessel Loading and Unloading Facilities.

(1) Marine Docks

NOTE: Show vugraph #55-76.

(2) Jetty and Marine Dock

NOTE: Show vugraph #55-77.

(3) Tanker Mooring and Submarine Pipeline

NOTE: Show vugraph #55-79.

(4) Pontoon Causeway

NOTE: Show vugraph #55-82.

(5) Floating Lines

NOTE: Show vugraph #55-83.

(6) Booster Pump Stations

NOTE: Show vugraph #56-100W5.

SUMMARIZING STATEMENT FOR THE HOUR

---------------------------- SECOND HOUR ---------------------------------

INTRODUCTORY STATEMENT FOR THE HOUR

e. Procedures Prior to Arrival of Tanker.

(1) Preliminary Actions

NOTE: Instructor explain the preliminary actions prior to arrival of a tanker.

(2) Inspection.

NOTE: Show vugraphs #55-84 and #55-85.

a. Check all connecting hoses for cracks and serviceability

b. Insure proper amount of hose for tide variations.

(3) Heated Cargo

NOTE: Show MF 10-7790 (FC #6), running time 16 min, critique film.

f. Tanker Unloading Procedures.

(1) Before Unloading Begins:

(a) Check Manifest and DD Form 250-1

(b) Take Ullages, Temperature, Check for Water in each compartment.

(c) All level samples on each compartment.

(2) Connecting Hose Procedures;

NOTE: Show vugraphs 55-86, 87 and 88.

(a) Properly ground vessel to dock.

(b) Drip Pans

NOTE: Show vugraphs #55-85, 55-89, 55-90, 55-91 and 55-92.

(c) Attach hose

(3) Unloading Operations:

(a) Open necessary valves (ship to shore)

(b) Start pump and adjust RPM

(c) Check for leaks

(d) In case of fire - stop operations and close valves

(e) Observe draft of vessel

(f) Top off tanks at reduced flowrate

(4) Follow up procedures to Unloading Operation.

(a) Allow shore tanks to settle at least 12 hours.

(b) Gage tanks and correct volume to 60° F.

(c) Take composite sample

(d) Inspect tank compartment of vessel and issue a dry tank certificate.

(e) Insure all valves are closed and disconnect hoses.

(f) Disconnect grounding cable.

(g) Record all tests on DD Form 250-1.

g. Tanker Loading Procedures.

(1) Bonding and grounding

NOTE: Instructor explain operations of grounding switch.

(2) Deballasting

NOTE: Instructor explain deballasting procedures.

(3) Inspection

(a) Inspect vessel loading plan

(b) Inspect all lines and connections.

(4) Load Lines:

(a) Fine "Plimsoll" Mark

(b) Indicates vessel draft limit, depending upon time of year and area of operation.

NOTE: Instructor summarize second hour of instruction.

---------------------------- THIRD HOUR ------------------------------------

INTRODUCTORY STATEMENT FOR THE HOUR

(5) Follow - Up procedures to loading tank vessels:

(a) Allow product time to settle.

(b) Obtain all level sample from each compartment.

(c) Gage shore tanks

(d) Gage vessel tanks, correct to 60° F. (TM 10-1101)

(e) Compare quantities delivered from shore tanks with quantities received in vessel tanks.

(f) Investigate any discrepancies in amount delivered and amount received.

(g) Disconnect hoses, close compartment hatches and disconnect ground switch.

(h) Clean up any spills.

h. Fire and Safety Precautions.

(1) Post all necessary "Warning Signs" prominently.

(2) Connect ship's fire hose to hydrant.

(3) Place all fire fighting equipment for immediate use.

(4) Inspect all hose nozzles, foam mixtures and valve wrenches.

(5) Use only approved explosionproof flashlights.

NOTE: Introduce TF 10-2855 (FC #64). Critique film at ending.

i. Ecology and Oil Spills.

(1) Over 1,000 oil spills occur each year.

(2) Any oil spilled into water should be cleaned up immediately.

(3) Any oil spill on deck should be cleaned up immediately.

(4) Major causes of oil spills.

(a) Natural causes

(b) Human errors

(c) Mechanical

(5) Clean-Up methods:

NOTE: Instructor explain each.

(a) Chemicals

(b) Air bubbles

(c) Sinkants

(d) Sorbents

(e) Mechanical equipment

(f) Burning

(6) Sludge disposal

(a) Mechanical tilling

(b) Weathering

NOTE: Instructor summarize third hour of instruction.

----------------------- FOURTH THRU EIGTH HOUR --------------------------------

INTRODUCE CLASSROOM PRACTICAL EXERCISE

3. APPLICATION (PE 2, 50 min, classroom, PE 1, 190 min).

a. Practical Exercise 2 (two instructors).

Instructor will have students turn to pages 123-127 in QMS 300.076, Vol IV, and fill out DD 250-1, hose testing record, and tanker activity report. Critique the practical exercise and instruct the class to move to the PTF for the fifth thru the eight hour of instruction.

b. Practical Exercise 1, (4 instructors).

(1) At the waterfront area the instructor will brief the class on dock operation and then the base terminal operations for this practical exercise. The class will be divided up into two groups.

(2) Group A will operate the tanker cargo pumps, tanker storage compartments, pipelines, and valves. Members of this group will also gage the storage compartments.

(3) Group B will operate the manifold and transfer pumps of base terminal. Students of this group will also gage the storage tanks which are being used. This group will furnish a pipeline patrol that will maintain a check on the lines being utilized.

(a) Using the groups assigned above, pump product from one of the storage tanks of base terminal through the manifold and transfer pump to the four cargo compartments of the tanker.

(b) After the tanker has been loaded, both the base terminal storage tank and the tanker compartments will be gaged. The volume transferred will be determined.

(c) Using the same groups of students at the same points, a tanker unloading operation will be performed.

(d) Product will be transferred from the compartments of the tanker through the cargo pump to a storage tank in base terminal.

(e) After the two groups have finished, rotate them and repeat the same tanker loading and unloading operations as outlined above.

4. REVIEW (Conference, 10 min).

a. Clarification of Points of Difficulty.

Ask for and answer any student questions on the material just covered.

b. Summary of the lesson.

QUESTION: What are the types of waterfront loading and unloading facilities?

ANSWER: Offshore loading and unloading and shore loading and unloading.

QUESTION: Name the types of offshore facilities.

ANSWER: Submarine lines and floating lines.

QUESTION: Name a type of shore facility.

ANSWER: Jetties, wharves and piers.

QUESTION: What is the purpose of bonding and grounding equipment?

ANSWER: It serves to ground stray currents and to equalize electrical charge between pier and vessel.

QUESTION: When multiple product cargoes arrive at unloading port, when are samples taken?

ANSWER: Before, during and after operation.

QUESTION: What are the three main causes of oil spills?

ANSWER: Natural, human and mechanical failure.

QUESTION: Name three ways to help clean up oil spills in water.

ANSWER: Sinkants, sorbents, and mechanical equipment.

c. Closing Statement.

The past 8 hours should have shown you the importance of waterfront operations in the theater of operations. As a result of this instruction you should be able to name four of the major operations used in loading and unloading tanker vessels. You should also be familiar with the proper hookup of waterfront hoseline. We have also covered some historical data on oil spills - the causes, prevention, recovery and disposal procedures, and also the laws governing oil spills. From material covered, we can readily see that our best defense against oil pollution is prevention. The chances are good that you will have to perform waterfront operations sometime in your military career and this class was designed to prepare you for it.

5. STANDBY MATERIAL:

Review Previous Material.

QMS 300.024 H3 747

COURSE OUTLINE

PETROLEUM SUPPLY SPECIALIST COURSE

PROPONENT DEPARTMENT: Petroleum and Field Services

February 1977

New

770

748

Hi! Here is a handy dandy outline of the subject areas and exams you will have to complete in order to get through this course. If you keep this outline with you, or at least where you can find it, you'll be able to follow your progress through this course. There is even a nifty place to keep track of your test scores. The course is broken down into five (5) annexes, A, B, C, D and E, for general subject areas and each annex is broken down into specific subjects and exams. At the completion of "E" Annex you will receive a genuine (for real!) DIPLOMA. Sometimes too many students get into the same area, so to prevent people from being trampled we have to juggle the areas of study. Because of this you won't always get the subjects in the same order listed. You will, however, get all the subjects sooner or later.

"A" ANNEX

This annex is a wee bit tough since you have two exams, but at least it is short. You should be able to complete it all in about four days.

1. INTRODUCTION - Here's where you get all that good information, like this outline. You meet your counselors, get your books, and if you are lucky, you can meet some of the brass from the Head Shed. You will also get a block of instruction on radios and telephones. Stay awake for this block because it is a big chunk of the A-10 exam. Draw a circle around the "1" when you finish the introduction.

2. VISUAL EXAMINATION - Sometimes called A-3, comes complete with programed text, movie, practical exercise and examination. Here you will learn to spot contamination in fuels and run a laboratory type test to check the gravity of fuels. When you finish, record your test score here. ☐ A-3

3. CATEGORIES OF PETROLEUM PRODUCTS (A-2) - This is a programed text that clues you in on all the different types of petroleum products you will handle as a Petroleum Supply Specialist. It helps to know what you are working with.

4. HEALTH AND HANDLING HAZARDS (A-4) - The object of this programed text and movie is to teach you enough about petroleum hazards to keep you from getting burned, choked, poisoned or otherwise spindled or mutilated. An ounce of prevention is worth a pound of cure and saves on asprin. Study this one well.

5. FIRE FIGHTING (A-5) - Another self paced program and three "HOT" films. This block tells you how to fight fires but more important, how to prevent them. WARNING - it has been determined that fire can be hazardous to your health.

6. TAMMS (A-9) - This is a "no fun" programed text on how to fill out standard forms. You will be plagued forever with forms in the Army so here's your chance to learn how to fill them out. Learn to do it here and save some asprin later.

7. EXAMINATION (A-10) - This is a written exam on everything you learned in "A" Annex except A-3. Be sure you study your programs well and your notes on the radio and telephone class. If you fail to pass you have to start all over again and that is a drag. Put your test score for A-10 here. ________
A-10.

NOTE: Annex B has been omitted by the U.S. Army.

"C" ANNEX

For most students, this is a fun annex. After studying each subject with programed text and TV films you get to operate a piece of equipment and then take a performance exam. For the person who likes to work with their hands, this annex is a change to improve your scores and save time. "C" Annex covers Class III Supply Point Operations and most 76W personnel work in this type operation after leaving this school.

1. INTRODUCTION (C-1) - Here is a short little handout. No exam on this, but study the rules well to avoid getting in trouble later on.

2. 50 GPM PUMP AND 500 GALLON COLLAPSIBLE DRUM (C-2) - It never fails - someone will get doused with fuel on this one. It is usually the first time you have ever worked with a powered pump, but if you study the text and film well, you should be able to avoid getting wet. Having a good knowledge of how this pump and engine works will make all the other engines and pumps easier to learn. Put your test score here. ☐

C-2

3. TANK & PUMP UNIT (C-4) - This pump is almost identical to the 50 GPM. It is mounted with two tanks on a tactical cargo truck. Follow the program closely and understand the flow of fuel in the manifold and you should pass this test with ease. Put your test score here ☐

C-4

4. 350 GPM PUMP AND FILTER SEPARATOR (C-6) - Now you're getting into bigger operations. This pump is the main pump in the FSSP (Fuel System Supply Point). Study this pump and filter separator closely. The exam carries a lot of raw points. Put your test score here. ☐

C-6

5. RIGGING FOR EXTERNAL HELICOPTER (C-5) - You got lucky on this block. Rigging for airlift is performed by professional riggers but you may be working with them sometimes. To familiarize yourself with this operation just sit back and enjoy a 30 minute film. It's actually a pretty good film and lucky you -- no exam on this.

6. OPERATION AND LAYOUT OF THE FSSP (C-7, C-10) - This block is going to require your thinking cap and a lot of muscle. The FSSP is designed to be moved frequently to stay close to combat units in the field. You will have to know how to set it up, take it down and operate it. The key to the whole thing is knowing how to control the flow of fuel in the system. Learn and really understand how to move the fuel the way you want it to and the rest is easy. The exam on this carries a lot of raw points. Put your test score here. ☐

C-7

7. AIRCRAFT REFUELING (C-3, C-9 & M49C) - In this block you get a big load. You learn how to set up and operate the FARE System, operate the 100 GPM pump and separator, and how to operate the M49C tank truck. You will take two exams on this at this station, one for the FARE System and one for the M49C. Put your test score here.

8. TANK VEHICLE OPERATIONS (C-8) - There are two programed texts. One for the M49C, 1200 gallon tanker and one for the M131, 5000 gallon tanker. You also have two films to see. There is also a briefing on the operation of the GOER, M559 tank truck. You won't be tested on the GOER but you may someday soon be using it so take good notes and pay attention. Put your test score here.

"D" ANNEX

This annex is devoted to Terminal Operations. The Army handles vast quantities of bulk fuels. As a result there are large tank farms and terminals to handle this big job. In this annex you will learn some of the tasks you will have to perform as a 76W if assigned to one of these terminals.

1. GAGING AND SAMPLING OF STORAGE TANKS (D-2, D-4) - Here is where a lot of students get in trouble. The main reason they get in trouble is because they try to rush through this block then find out that two exams are based on what they were supposed to have learned here. Gaging and sampling is one of the most important jobs you will ever have to do. You have three films and two programed texts to complete before doing the programed practical exercise. Study your programs carefully and follow directions closely. You will get an exam on this when you finish but it is only one part of a three part exam. You will get the total score when you finish part III of D-11 exam.

2. VOLUME CORRECTIONS (D-3) - If you can add, subtract, and multiply, this will be a snap. If you have trouble with math this is a headache for sure. Put your score here. ☐

756

3. VALVES, PIPES AND FITTINGS (D-5) - This programed text explains different types of valves, what they are used for and how to service them. You shouldn't have any problem here if you study the program carefully.

4. MANIFOLDS (D-6) - The first time you look at a manifold system with all its pipes and valves you might be reminded of a Chinese jigsaw puzzle or a for real nightmare. The programed text on this makes it easy if you follow it step by step very carefully.

5. TRANSFER PUMP (D-7) - In this block you'll learn how to operate and maintain the six inch single stage pump. This is the biggest pump you have had yet. You will also find it is one of the easiest to operate.

6. RAIL TANK CARS (D-8) - In this block you learn how to load and unload the rail tank car. You will be working with other students who are operating the manifold and transfer pump when you load and unload the rail tank car. Be sure you do everything the programed text requires. You have to gage and sample the rail car in this block also. After you finish this you'll get Part II of D-11 exam. Part II cover D-5, D-6, D-7 and D-8.

779

7. TANK MAINTENANCE (D-9) - This program is short and sweet. You won't have to clean any storage tanks in this course but you must learn to use the safety equipment so if you get on a tank cleaning team you will know how to work safely.

8. WATERFRONT OPERATIONS (D-10) - In this block you will learn the safe way to load, unload and gage sea going tankers. The big thing here is safety and which forms to fill out. Namely the DD 250-1 and the dry tank certificate. After this block you get Part III of D-11 exam. Now you get a total score for D-11. ☐

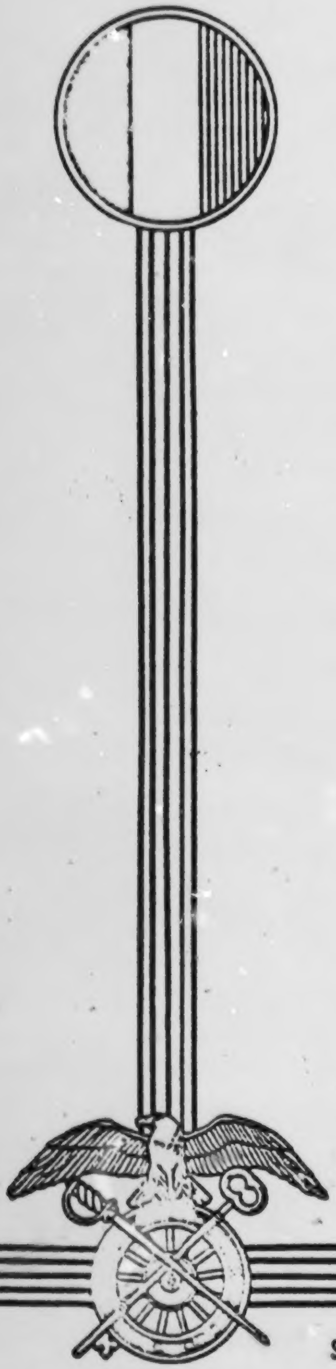
"E" ANNEX

This is your final annex. You will get this whole annex in what we call "LOCK STEP." This means no more programed text. You will go through this annex with a group of students and the instructors will teach the whole annex to you. In this annex you will learn to operate the pipeline pump station and four inch four stage pump. You will learn how to patrol a pipeline and make temporary repairs. You will also get to see the glass pipeline in operation and see how a multi-product pipeline works. The exam is a tough one so stay awake. Put your score here. ☐

Well there you have it in a nutshell. After you successfully complete "E" Annex you will get a diploma and be welcomed to the POL family. You will be part of a big, hard working bunch of drum humpers who keep the Army moving. Good luck and have a great career!!

759

NIPUB 358(ST)



PETROLEUM SUPPLY SPECIALIST
MOS 76W10

PETROLEUM REFERENCES AND GLOSSARY

U.S. ARMY QUARTERMASTER SCHOOL
FORT LEE, VIRGINIA

SUPPLY TRAINING CENTER OF THE ARMY SCHOOL SYSTEM
ATSM-DT-TM-OT-ET
MAY 1978
REPRINT DATE JUNE 1979

Army–Fort Lee, Va. [illegible]

782

760

PART ONE

REFERENCES

INTRODUCTION. Part One of this special text lists selected reference material for petroleum products, organizations, equipment, and facilities. The appropriate military publications or indexes should be checked to find the date of the most recent publication and to verify changes to the basic reference for each section of this list. (The basic reference or references for each type of publication are given at the bottom of the page where the list of that type publication begins.)

783

1. DEPARTMENT OF DEFENSE PUBLICATIONS*

(When DOD publications cannot be obtained through regular publication supply channels, submit requests to

Defense Publications Center
Cameron Station
Alexandria, VA 22314)

DOD 4140.25-M	Procedures for the Management of Petroleum Products
DOD Directive 5030.41	Implementing the National Oil and Hazardous Substances Pollution Contingency Plan (See Miscellaneous Publications)
	DOD Index of Specifications and Standards, Part I, Alphabetical Listing
	DOD Index of Specifications and Standards, Part II, Numerical Listing
MIL-HDBK-200D	Military Standardization Handbook· Quality Surveillance Handbook f Fuels and Lubricants (Overseas Areas)
MIL-HDBK-201B	Military Standardization Handbook: Petroleum Operations
MIL-HDBK-210	Military Standardization Handbook: Conversion Factors and Logistics Data for Petroleum Planning
DFSCH 4120.1	Reference List of Specifications and Standards for Petroleum and Related Products

(The above publication may be obtained by submitting requests to

Commander
DFSC
ATTN: DFSC-T
Cameron Station
Alexandria, VA 22314)

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*References: DOD Directive System (Quarterly Listing of Unclassified Issuance and Subject Index, and DOD Index of Specifications and Standards, Parts I and II.

2. ARMY REGULATIONS*

(When Army regulations cannot be obtained through regular publication supply channels, submit requests to

U.S. Army Adjutant General
Publications Center
2800 Eastern Blvd.
Baltimore, MD 21220)

11-21	Environmental Pollution Abatement
37-15	Budget Development and Review
37-20	Administrative Control of Appropriated Funds
37-111	Working Capital Funds: Army Stock Fund Uniform Policies, Principles, and Procedures Governing Army Stock Fund Operations
55-228	Transportation by Water of Explosives and Hazardous Cargo
55-355	Military Traffic Management Regulation
56-9	Watercraft
210-58	Sale of Petroleum Products
310-25	Dictionary of United States Army Terms (Short Title: AD)
310-50	Authorized Abbreviations and Brevity Codes
385-10	Army Safety Program
385-30	Safety Color Code Markings and Signs
385-40	Accident Reporting and Records

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* Reference: DA Pamphlet 310-1, Index of Administrative Publications.

420-42	Solid Fuels
420-56	Permanently Installed Petroleum Products Storage, Distribution, and Dispensing System
420-90	Fire Prevention and Protection
700-36	Quality Surveillance and Laboratory Facilities for Petroleum Products in Oversea Areas
700-47	Defense Standardization Program
700-68	Safe Handling, Storing, Shipping, Use, and Disposal of Compressed Gas Cylinders
703-1	Petroleum Supply and Management Activities
703-2	Bulk Petroleum Terminal Report - Reports Control Symbol CSGLD-1564 (OPNAVINST 4020.23A/ AFR 144-3)
708-1	Cataloging and Supply Management Data.
710-2	Materiel Management for Using Units, Support Units, and Installations
715-17	Report of Cost and Analysis - Buildings, Liquid Fuel Facilities, and Paving
725-50	Requisitioning, Receipt, and Issue System
735-11	Accounting for Lost, Damaged, and Destroyed Property
740-25	Bulk Petroleum Storage Facilities - Reports Control Symbol DD-I & L(A)506 (DSAR 4220.1/ OPNAVSUPINST 4020.6/AFR 67-141/ MCO 4870.46A)

740-26	Physical Inventory Control
746-1	Preparation of Equipment for Shipment
750-13	Spectrometric Oil Analysis
750-20	Maintenance of Supplies and Equipment: Prevention, Control, and Abatement of Pollution from Mobile Equipment

3. DEPARTMENT OF THE ARMY PAMPHLETS*

(When DA pamphlets cannot be obtained through regular publication supply channels, submit requests to

U.S. Army Adjutant General
Publications Center
2800 Eastern Blvd.
Baltimore, MD 21220)

108-1	Index of Army Motion Pictures and Related Audio-Visual Aids
310-1	Index of Administrative Publications (Regulations, Circulars, Pamphlets, Posters, Joint Chiefs of Staff Publications, and General Orders)
310-2	Index of Blank Forms
310-3	Index of Doctrinal, Training, and Organizational Publications (Field Manuals, Training Circulars, Army Training Programs, Army Subject Schedules, Army Training Tests, Firing Tables and Trajectory Charts, Tables of Organization and Equipment, Type Tables of Distribution, and Tables of Allowances)

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* Reference: DA Pamphlet 310-1, Index of Administrative Publications.

310-4	Index of Technical Manuals, Technical Bulletins, Supply Manuals (Types 7, 8, and 9), Supply Bulletins, and Lubrication Orders
310-6	Index of Supply Catalogs and Supply Manuals (Excluding Types 7, 8, and 9)

4. FIELD MANUALS*

(When field manuals cannot be obtained through regular publication supply channels, submit requests to

U.S. Army Adjutant General
Publications Center
2800 Eastern Blvd.
Baltimore, MD 21220)

10-13	Supply and Service Reference Data
10-67	Petroleum Supply in Theaters of Operations
10-227	Petroleum Supply Company
29-3	Direct Support Supply and Service in the Field Army
29-45	General Support Supply and Service in the Field Army
29-45-1 (Test)	General Support Supply and Service in the Field Army
29-50	Supply and Services in Divisions and Separate Brigades
29-147	Supply and Service Company, Direct Support
54-1	The Logistical Command

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* Reference: DA Pamphlet 310-3, Index of Doctrinal, Training, and Organizational Publications.

54-2	The Division Support Command and Separate Brigade Support Battalion
54-3	The Field Army Support Command
54-4	The Support Brigade
54-7	The Theater Army Support Command
55-1	Army Transportation Services in a Theater of Operations
55-15	Transportation Reference Data
61-100	The Division
101-5	Staff Officers' Field Manual: Staff Organization and Procedure
101-10-1	Staff Officers' Field Manual: Organizational, Technical, and Logistical Data
101-10-2	Staff Officers' Field Manual: Organizational, Technical, and Logistical Data Extracts of Nondivisional Tables of Organization and Equipment

5. TABLES OF ORGANIZATION AND EQUIPMENT*

The letter designations of TOE's are omitted. Use the most recent publication.

(When tables of organization and equipment cannot be obtained through regular publication supply channels, submit requests to

U.S. Army Adjutant General
Publications Center
2800 Eastern Blvd.
Baltimore, MD 21220)

5-177	Engineer Pipeline Construction Support Company

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* Reference: DA Pamphlet 310-3, Index of Doctrinal, Training, and Organizational Publications.

10-7	Supply and Service Company, Supply and Transport Battalion, Armored Division or Supply and Service Company, Supply and Transport Battalion, Infantry Division, or Supply and Service Company, Supply and Transport Battalion, Infantry Division (Mechanized)
10-37	Supply Company, Support Command, Airborne Division
10-201	Headquarters and Headquarters Company, Petroleum Brigade
10-202	Headquarters and Headquarters Detachment, Petroleum Group
10-205	Petroleum Operating Battalion
10-206	Headquarters and Headquarters Company, Petroleum Operating Battalion
10-207	Petroleum Operating Company
10-226	Headquarters and Headquarters Company, Petroleum Supply Battalion
10-227	Petroleum Supply Company
10-458	Quartermaster Petroleum Supply Company, Forward
10-475	Quartermaster Petroleum Supply Battalion (Army)
10-476	Headquarters and Headquarters Company, Quartermaster Petroleum Supply Battalion (Army)
10-477	Quartermaster Petroleum Supply Company (Army)
10-500	Quartermaster Service Organization

29-215	Supply and Service Battalion, Direct Support
29-216	Headquarters and Headquarters Company, Supply and Service Battalion, Direct Support
29-217	Supply and Service Company, Supply and Service Battalion, Direct Support

6. ARMY TRAINING PROGRAMS*

(When Army training programs cannot be obtained through regular publication supply channels, submit requests to

U.S. Army Adjutant General
Publications Center
2800 Eastern Blvd.
Baltimore, MD 21220)

10-202	Headquarters and Headquarters Detachment, Petroleum Group (TOE 10-202)
10-205	Petroleum Operating Battalion
10-475	Quartermaster Army Petroleum Supply Battalion
29-115	Supply and Service General Support Battalion, Forward
29-215	Supply and Service Battalion, Direct Support

7. ARMY TRAINING TESTS*

(When Army training tests cannot be obtained through regular publication supply channels, submit requests to

U.S. Army Adjutant General
Publications Center
2800 Eastern Blvd.
Baltimore, MD 21220)

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* Reference: DA Pamphlet 310-3, Index of Doctrinal, Training, and Organizational Publications.

10-34	Quartermaster Petroleum Products Laboratory Detachment (Base) (TOE 10-500, Team JB) Petroleum Products Laboratory Detachment (Mobile) (TOE 10-500, Team JC)
10-205	Petroleum Operating Battalion
10-226	Petroleum Supply Battalion (TOE 10-226, 10-227, and 55-18)
10-475	Quartermaster Army Petroleum Supply Battalion
29-115	Supply and Service General Support Battalion, Forward
29-215	Supply and Service Battalion, Direct Support

8. ARMY SUBJECT SCHEDULES*

(When Army subject schedules cannot be obtained through regular publication supply channels, submit requests to

U.S. Army Adjutant General
Publications Center
2800 Eastern Blvd.
Baltimore, MD 21220)

10-8	Petroleum Supply
10-76W20	MOS Technical Training of Petroleum Storage Specialist (MOS 76W20)

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* Reference: DA Pamphlet 310-3, Index of Doctrinal, Training, and Organizational Publications.

9. TECHNICAL MANUALS*

(When technical manuals cannot be obtained through regular publication supply channels, submit requests to

U.S. Army Adjutant General
Publications Center
1655 Woodson Road
St. Louis, MO 63114)

5-301	Engineer Functional Components System, Staff Tables of Installations, Facilities, and Equipages
5-302	Construction in the Theater of Operations
5-303	Bills of Materials and Equipment of the Engineer Functional Components System
5-315	Firefighting and Rescue Procedures in Theaters of Operations
5-343	Military Petroleum Pipeline Systems
5-678	Repairs and Utilities: Petroleum, Oils, and Lubricants (POL)
5-687	Repairs and Utilities: Fire Protection Equipment and Appliances, Inspections, Operations, and Preventive Maintenance
5-848-1	Fuel Supply Facilities: Gas Distribution
5-848-2	Storage, Distribution, and Dispensing of Aircraft and Automotive Fuels
5-2072	Pump, Centrifugal, for Petroleum Products, Gasoline-Driven, Self-Priming, Skid-Mounted,

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* Reference: DA Pamphlet 310-4, Index to Technical Manuals, Technical Bulletins, Supply Manuals (Types 7, 8, and 9), Supply Bulletins, and Lubrication Orders.

	Single Stage, 6-In., 350-BPH at 215-Ft. Head at 1,800 RPM (Reiner Model GP 58) (Less Engine)
5-2510-201-15	Operator, Organizational, Field and Depot Maintenance Manual: Body, Cargo, Pipeline Construction, MIL-SPEC-T-11966 (All Makes and Models) FSN 2510-511-7914
5-2510-201-25P	Organizational, Field and Depot Maintenance Repair Parts and Special Tool Lists: Body, Cargo, Pipeline Construction, MIL-SPEC-T-11966 (All Makes and Models) FSN 2510-511-7914
5-4320-200-15	Operator, Organizational, Direct Support, General Support and Depot Maintenance Manual Including Repair Parts and Special Tool Lists: Pump, Centrifugal, Frame-Mounted, 1 1/2-In., MIL-P-14514A(CE), Gasoline-Engine-Driven, Less Engine (Barnes Model 17570) FSN 4320-752-9466; Electric-Motor-Driven (Barnes Model 22270) FSN 4320-970-6223; Electric-Motor-Driven (Barnes Model US4CCE) FSN 4320-937-8099; Electric-Motor-Driven (Carver Model KEM155S) FSN 4320-810-7309
5-4320-210-12	Operator and Organizational Maintenance Manual: Pump, Centrifugal, Petroleum; Gasoline-Driven; Skid-Mounted; 4-In., 175-GPM 560-Ft. Head, 595-GPM 450-Ft. Head (Consolidated Diesel Model 4093) FSN 4320-691-0967
5-4320-210-25P	Organization, Direct Support, General Support, and Depot Maintenance Repair Parts and Special Tools List: Pump,

	Centrifugal, Petroleum; Gasoline-Driven; Skid-Mounted; 4-In., 175-GPM 560-Ft. Head, 595-GPM 450-Ft. Head (Consolidated Diesel Model 4093) FSN 4320-691-0967
5-4320-210-35	Field and Depot Maintenance Manual: Pump, Centrifugal, Petroleum, Gasoline-Driven, Skid-Mounted, 4-In., 175-GPM 560-Ft. Head, 595-GPM 450-Ft. Head, (Consolidated Diesel Model 4093) FSN 4320-691-0962
5-4320-211-12	Operator and Organizational Maintenance Manual: Pump, Centrifugal, Petroleum, Gasoline-Driven, Skid-Mounted, 6-In., 245-GPM 215-Ft. Head to 1,120-GPM 100-Ft. Head (Kurz and Root Model Baldy I) FSN 4320-715-7599
5-4320-211-20P	Organizational Maintenance Repair Parts and Special Tool Lists: Pump, Centrifugal, Petroleum, Gasoline-Driven, Skid-Mounted, 6-In., 245-GPM 215-Ft. Head to 1,120-GPM 100-Ft. Head (Kurz and Root Model Baldy I) FSN 4320-715-7599
5-4320-213-12	Operator and Organizational Maintenance Manual: Pump, Centrifugal, Petroleum, Gasoline-Driven, Skid-Mounted, 6-In., 500-GPM 555-Ft. Head to 1,400-GPM 275-Ft. Head (Allis-Chalmers Model 501-11-520) FSN 4320-709-2807
5-4320-213-20P	Organizational Maintenance Repair Parts: Pump, Centrifugal, Petroleum, Gasoline-Driven, Skid-Mounted, 6-In., 500-GPM 555-Ft. Head to 1,400-GPM 275-Ft. Head (Allis-Chalmers Model 501-112-520) FSN 4320-709-2807

5-4320-213-35	Field and Depot Maintenance Manual: Pump, Centrifugal, Petroleum, Gasoline-Driven, Skid-Mounted, 6-In., 500-GPM 555-Ft. Head to 1,400-GPM 275-Ft. Head (Allis-Chalmers Model 501-112-520) FSN 4320-708-2807
5-4320-213-35P	Direct Support, General Support, and Depot Maintenance Repair Parts: Pump, Centrifugal, Petroleum, Gasoline-Driven, Skid-Mounted, 6-In., 500-GPM 555-Ft. Head to 1,400-GPM 275-Ft. Head (Allis-Chalmers Model 501-112-520) FSN 4320-709-2807
5-4320-217-15	Organizational, Direct Support, General Support, and Depot Maintenance Manual: Pump, Centrifugal, Petroleum, Gasoline-Driven, Skid-Mounted, 6-In., 500-GPM 555-Ft. Head to 1,400-GPM 275-Ft. Head (Brielle Marine and Industrial Equipment Model PP113) FSN 4320-988-1192
5-4320-217-20P	Organizational Maintenance Repair Parts and Special Tools Lists: Pump, Centrifugal, Petroleum, Gasoline-Driven, Skid-Mounted, 6-In., 500-GPM 555-Ft. Head to 1,400-GPM 275-Ft. Head (Brielle Marine and Industrial Equipment Model PP113) FSN 4320-988-1192
5-4320-217-35P	Direct Support, General Support, and Depot Maintenance Repair Parts and Special Tools Lists: Pump, Centrifugal, Petroleum, Gasoline-Driven, Skid-Mounted, 6-In., 500-GPM 555-Ft. Head to 1,400-GPM 275-Ft. Head (Brielle Marine and Industrial Equipment Model PP113) FSN 4320-988-1192

5-4320-218-15	Operator, Organizational, Direct Support, General Support and Depot Maintenance Manual: Pump, Centrifugal, Petroleum, Gasoline-Driven, Trailer-Mounted, 4-In., 350-GPM 275-Ft. Head (Gorman-Rupp Model 04A12-MVG4D) FSN 4320-069-8494
5-4320-218-25P	Organizational Maintenance Repair Parts and Special Tools List: Pump, Centrifugal, Petroleum, Gasoline-Driven, Trailer-Mounted, 4-In., 350-GPM 275-Ft. Head (Gorman-Rupp Model 04A12-MVG4D) FSN 4320-691-1071; (Gorman-Rupp Model 04A12B-MVG4D) FSN 4320-069-8494
5-4320-218-35P	Direct and General Support and Depot Maintenance Repair Parts and Special Tools List: Pump, Centrifugal, Petroleum, Gasoline-Driven, Trailer-Mounted, 4-In., 350-GPM 275-Ft. Head (Gorman-Rupp Model 04A12-MVG4D) FSN 4320-069-1071; (Gorman-Rupp Model 04A12B-MVG4D) FSN 4320-069-8494
5-4320-225-20P	Organizational Maintenance Repair Parts and Special Tools Lists: Pump, Centrifugal, Petroleum Pipeline, Gasoline-Driven, Skid-Mounted (Barnes Manufacturing Model CE4P-4) FSN 4320-542-4037; (John Reiner Model GP75) FSN 4320-389-6957; (Peerless Pump Division Model 4INUSPL) FSN 4320-203-2546
5-4320-225-35P	Direct Support, General Support, and Depot Maintenance Repair Parts and Special Tools List: Pump, Centrifugal, Petroleum

	Pipeline, Gasoline-Driven, Skid-Mounted (Barnes Manufacturing Model CE4P4) FSN 4320-542-4037; (John Reiner Model GP75) FSN 4320-389-6857; (Peerless Pump Division Model 4INUSPL) FSN 4320-203-2546
5-4320-233-15	Operator, Organizational, Direct Support, General Support, and Depot Maintenance Manual: Pump, Centrifugal, Gasoline-Driven, Skid-Mounted, 6-In., 1,120-GPM, Self-Priming (Carver Model K906EWA) FSN 4320-968-6264
5-4320-233-20P	Organizational Maintenance Repair Parts and Special Tools Lists: Pump, Centrifugal, Gasoline-Driven, Skid-Mounted, 6-In., 1,120-GPM, Self-Priming (Carver Model K906EWA) FSN 4320-968-6264
5-4320-233-35P	Direct Support, General Support, and Depot Maintenance Repair Parts and Special Tools List: Pump, Centrifugal, Gasoline-Driven, Skid-Mounted, 6-In., 1,120-GPM, Self-Priming (Carver Model K906EWA) FSN 4320-968-6264
5-4320-237-15	Operator, Organizational, Direct, and General Support and Depot Maintenance Manual: Pump, Centrifugal, Gasoline-Engine-Driven, 500-GPM 100-Ft. Head, Flammable Liquid, Bulk Tranfer (Barnes Model QM-2-28002) FSN 4320-913-7131
5-4320-237-25P	Organizational, Direct Support, and General Support, and Depot Maintenance Repair Parts and Special Tool Lists: Pump,

	Centrifugal, Gasoline-Engine-Driven, 50-GPM 100-Ft. Head, Flammable Liquid, Bulk Transfer (Barnes Model QM-2-28002) FSN 4320-913-7131
5-4320-240-15	Operator, Organizational, Direct Support, General Support and Depot Maintenance Manual: Pump, Centrifugal, Gasoline-Engine-Driven, Skid-Mounted, 6-In., 1,120-GPM (Carver Model K906MP) FSN 4320-929-0681
5-4320-240-25P	Organizational, Direct Support, General Support, and Depot Maintenance Repair Parts and Special Tools Lists: Pump, Centrifugal, Gasoline-Engine-Driven, Skid-Mounted, 6-In., 1,120-GPM (Carver Model K906MP) FSN 4320-929-0681
5-4320-242-15	Operator, Organizational, Direct Support, General Support, and Depot Maintenance Manual: Pumping Assembly, Flammable Liquid, Bulk Transfer, Gasoline-Engine-Driven, 350-GPM Capacity at 190-Ft. Head, Wheel-Mounted (Gorman-Rupp Model 84C15-4A084) FSN 4320-916-9172
5-4320-242-20P	Organizational Maintenance Repair Parts and Special Tool Lists: Pumping Assembly, Flammable Liquid, Bulk Transfer, Gasoline-Engine-Driven, 350-GPM Capacity at 190-Ft. Head, Wheel-Mounted (Gorman-Rupp Model 84C15-4A084) FSN 4320-916-9172
5-4320-242-35P	Direct Support, General Support, and Depot Maintenance Repair Parts and Special Tool Lists: Pumping Assembly, Flammable

	Liquid, Bulk Transfer, Gasoline-Engine-Driven, 350-GPM Capacity at 190-Ft. Head, Wheel-Mounted (Gorman-Rupp Model 84C15-4A084) FSN 4320-916-9172
5-4320-243-15	Operator, Organizational, Direct Support, General Support, and Depot Maintenance Manual: Pump, Centrifugal, Petroleum Pipeline, Gasoline-Engine-Driven, Skid-Mounted, 500-GPM to 1,400-GPM (John Reiner Model GP 110-5) FSN 4320-063-7368
5-4320-243-20P	Organizational Maintenance Repair Parts and Special Tools List: Pump, Centrifugal, Petroleum Pipeline, Gasoline-Engine-Driven, Skid-Mounted, 500-GPM to 1,400-GPM (John Reiner Model GP 110-5) FSN 4320-063-7368
5-4320-243-35P	Direct and General Support and Depot Maintenance Repair Parts and Special Tool Lists: Pump, Centrifugal, Petroleum Pipeline, Gasoline-Engine-Driven, Skid-Mounted, 500-GPM to 1,400-GPM (John Reiner Model GP 110-5) FSN 4320-063-7368
5-4320-248-15	Operator, Organizational, Direct and General Support and Depot Maintenance Manual: Fuel System, Transfer, Portable, Pump, Centrifugal, 100-GPM, Two Discharge Hose Assemblies, One Suction Hose Assembly, Two Non-Automatic Nozzle Assemblies, One Monitor Go-No-Go Gage, 100-GPM, 3-HP Gasoline Engine, One Basket Assembly (Kenco Model 114MX1A) FSN 4320-900-8544

5-4320-248-25P	Organizational, Direct and General Support and Depot Maintenance Repair Parts and Special Tools List: Fuel System, Transfer, Portable, Pump, Centrifugal, 100-GPM, Two Discharge Hose Assemblies, One Suction Hose Assembly, Two Non-Automatic Nozzle Assemblies, One Monitor Go-No-Go Gage, 100-GPM, 3-HP Gasoline Engine, One Basket Assembly, (Kenco Model 114MX1A) FSN 4320-900-8544
5-4320-250-15	Operator, Organizational, Direct Support, General Support, and Depot Maintenance Manual: Pump, Centrifugal, Petroleum Pipeline, Gasoline-Engine-Driven, Skid-Mounted, 2-Stage, 6-In., 500-GPM at 555-Ft. Head to 1,400-GPM at 275-Ft. Head (International Fermont Model M-715-P) FSN 4320-122-9642
5-4320-250-20P	Organizational Maintenance Repair Parts and Special Tool Lists: Pump, Centrifugal, Petroleum Pipeline, Gasoline-Engine-Driven, Skid-Mounted, 2-Stage, 6-In., 500-GPM at 555-Ft. Head to 1,400-GPM at 275-Ft. Head (International Fermont Model M-715-P) FSN 4320-122-9642
5-4320-250-35P	Direct and General Support and Depot Maintenance Repair Parts and Special Tool Lists: Pump, Centrifugal, Petroleum Pipeline, Gasoline-Engine-Driven, Skid-Mounted, 2-Stage, 6-In., 500-GPM at 555-Ft. Head to 1,400-GPM at 275-Ft. Head (International Fermont Model M-715-P) FSN 4320-122-9642

5-4320-258-12	Operator and Organizational Maintenance Manual: Pump, Centrifugal, Petroleum, Gasoline-Engine-Driven, 6-In., 1,120-GPM, Skid-Mounted (Barnes Model US67CCG) FSN 4320-409-8678
5-4320-258-20P	Organizational Maintenance Repair Parts and Special Tools Lists: Pump, Centrifugal, Petroleum, Gasoline-Engine-Driven, 6-In., 1,120-GPM, Skid-Mounted (Barnes Model US67CCG) FSN 4320-409-8678
5-4320-258-34	Direct Support and General Support Maintenance Manual: Pump, Centrifugal, Petroleum, Gasoline-Engine-Driven, 6-In., 1,120-GPM, Skid-Mounted (Barnes Model US67CCG) FSN 4320-409-8678
5-4320-258-34P	Direct and General Support Maintenance Repair Parts and Special Tools Lists: Pump, Centrifugal, Petroleum, Gasoline-Engine-Driven, 6-In., 1,120-GPM, Skid-Mounted (Barnes Model US67CCG) FSN 4320-409-8678
5-4320-259-12	Operator and Organizational Maintenance Manual: Pumping Assembly, Flammable Liquid, Bulk Transfer, Lightweight, Centrifugal, 100-GPM Minimum, Gasoline-Engine-Driven (Barnes Model US6ACG) FSN 4320-150-6116
5-4320-259-20P	Organizational Maintenance Repair Parts and Special Tools List: Pumping Assembly, Flammable Liquid, Bulk Transfer, Lightweight, Centrifugal,

	100-GPM Minimum, Gasoline-Engine-Driven (Barnes Model US6ACG) FSN 4320-150-6116
5-4320-259-34	Direct Support and General Support Maintenance Manual: Pumping Assembly, Flammable Liquid, Bulk Transfer, Lightweight, Centrifugal, 100-GPM Minimum, Gasoline-Engine-Driven (Barnes Model US6ACG) FSN 4320-150-6116
5-4320-259-34P	Direct Support and General Support and Depot Maintenance Repair Parts and Special Tool Lists: Pumping Assembly, Flammable Liquid, Bulk Transfer, Lightweight, Centrifugal, 100-GPM Minimum, Gasoline-Engine-Driven (Barnes Model US6ACG) FSN 4320-150-6116
5-4330-200-15	Operator, Organizational, Field and Depot Maintenance Manual: Separator, Water, Liquid Fuel, Skid-Mounted, 350-GPM, 4-In. (Warner Lewis Model VFCS-1061-9A2ANW) FSN 4330-705-5965, Component of 4930-542-2518 Petroleum Supply Point Assemblage
5-4330-200-25P	Organizational, Field and Depot Maintenance Repair Parts and Special Tool Lists: Separator, Water, Liquid Fuel, Skid-Mounted, 350-GPM, 4-In. (Warner Lewis Model VFCS-1061-9A2ANW) FSN 4330-705-5965, Component of 4930-542-2518 Petroleum Supply Point Assemblage
5-4330-211-12	Operator and Organizational Maintenance Manual Including Repair Parts and Special Tools List: Filter-Separator,

	350-GPM Optimum Performance (General Steel Tank Model 0217) FSN 4330-150-6123
5-4330-214-15	Operator, Organizational, Direct and General Support and Depot Maintenance Manual Including Repair Parts and Special Tool Lists: Filter-Separator, Liquid Fuel, 600-GPM (General Steel Tank Model 0201) FSN 4330-060-7188
5-4330-215-12	Operator and Organizational Maintenance Manual Including Repair Parts and Special Tools List: Filter-Separator, Liquid Fuel, Ground-Mounted, 50-GPM (Bendix Model 050584) FSN 4330-998-6028
5-4330-220-12	Operator and Organizational Maintenance Manual Including Repair Parts and Special Tool Lists: Filter-Separator, Liquid Fuel, 15-GPM, Aluminum, Skid-Mounted (Bowser Model 844-1-V15-AL) FSN 4330-570-9652
5-4330-230-12	Operator and Organizational Maintenance Manual Including Repair Parts and Special Tool Lists: Filter-Separator, Liquid Fuel, 15-GPM, Aluminum, Skid-Mounted (United Model 9149) FSN 4330-490-5370
5-4330-231-13	Operator, Organizational, and Direct Support Maintenance Manual Including Repair Parts and Special Tools List: Filter-Separator, Liquid Fuel, 350-GPM, Skid-Mounted (General Steel Tank Model FS 0215) FSN 4330-480-7343
5-4330-232-12	Operator and Organizational Maintenance Manual Including

	Repair Parts and Special Tools List: Filter-Separator, Liquid Fuel, 50-GPM, Frame-Mounted (General Steel Tank Model FS0216A101) FSN 4330-444-7117
5-4330-233-12	Operator and Organizational Maintenance Manual Including Repair Parts and Special Tool Lists: Filter-Separator, Liquid Fuel, 50-GPM, Nonframe-Mounted (Keene Model 844-4V50AL) FSN 4330-165-4900
5-4930-212-15	Operator, Organizational, Direct Support, General Support and Depot Maintenance Manual: Fueling Systems, Air-Transportable, 100-GPM Pump, 2,000-Gallon Stabilized Fabric Tank (Air Logistics Corp. Model 11214-521) FSN 4930-912-3539; 100-GPM Pump with four 500-Gallon Tank Assemblies (Air Logistics Corp. Model 11214-527) FSN 4930-999-2814; 100-GPM Pump with four 500-Gallon Tank Assemblies and 30-GPM Pump Assembly (Air Logistics Corp. Model 111214-533) FSN 4930-994-4616 and Fill Stand System, 300-GPM Pump with two 10,000-Gallon Fabric Tanks (Air Logistics Corp. Model 113379) FSN 4930-999-2815 and Filter-Separator, Metering Unit, Liquid Fuel, 100-GPM Pump Assembly with Flow Dividers and Hose Assemblies (Air Logistics Corp. Model 114616) FSN 4930-902-3105
5-4930-212-25P	Organizational, Direct and General Support and Depot Maintenance Repair Parts and Special Tool Lists: Fueling Systems, Air-Transportable,

	100-GPM Pump, 2,000-Gallon Stabilized Fabric Tank (Air Logistics Corp. Model 111214-521) FSN 4930-912-3539; 100-GPM Pump with four 500-Gallon Tank Assemblies (Air Logistics Corp. Model 11214-527) FSN 4930-999-2814; 100-GPM Pump with four 500-Gallon Tank Assemblies and 30-GPM Pump Assembly (Air Logistics Corp. Model 11214-533) FSN 4930-994-4616 and Fill Stand System, 300-GPM Pump with two 10,000-Gallon Fabric Tanks (Air Logistics Corp. Model 113379) FSN 4930-999-2815 and Filter-Separator, Metering Unit, Liquid Fuel, 100-GPM Pump Assembly with Flow Dividers and Hose Assemblies (Air Logistics Corp. Model 114616) FSN 4930- 902-3105
5-4930-220-12	Operator and Organizational Maintenance Manual Including Repair Parts and Special Tool Lists: Tank Unit, 600-Gallon, Liquid Dispensing for Trailer Mounting (Advance Model TRL 1616) (Highland Model TRL 2500) FSN 4930-752-9983
5-4930-221-14	Operator, Organizational, Direct and General Support Maintenance Manual: Forward Area Refueling Equipment (Bendix Model 53E00-70A) FSN 4930-087-7494
5-4930-221-24P	Organizational, Direct and General Support Maintenance, Repair Parts and Special Tools Lists: Forward Area Refueling Equipment (Bendix Corp. Model 53E00-70A) FSN 4930-087-7494

5-4930-222-15	Operator, Organizational, Direct and General Support and Depot Maintenance Manual Including Repair Parts and Special Tools List: Drum and Pump Unit, Liquid Dispensing, Cargo-Carrier Mounting (Gorman-Rupp Model 607) FSN 4930-089-8092
5-4930-22/-14	Operator, Organizational, Direct and General Support Maintenance Manual: Tank and Pump Unit, Liquid Dispensing for Truck Mounting (Highland Industries Model 2000) FSN 4930-877-8687
5-4930-227-24P	Organizational, Direct and General Support Maintenance, Repair Parts and Special Tools List: Tank and Pump Unit, Liquid Dispensing for Truck Mounting (Highland Industries Model 2000) FSN 4930-877-8678
5-5430-209-12	Operator and Organizational Maintenance Manual: Tank, Steel, Vertical, Bolted, Knockdown, Sealed Openings Standard Bottom and Reef, Gasoline, Oil or Water, 100-Barrel Capacity, FSN 5430-263-6276; 250-Barrel Capacity, FSN 5430-263-6080; 500-Barrel Capacity, FSN 5430-263-6077; 1,000-Barrel Capacity, FSN 5430-263-6078; 3,000-Barrel Capacity, FSN 5430-263-6075; 10,000-Barrel Capacity, FSN 5430-255-6073
9-2320-209-10	Operator Manual for 2 1/2-Ton, 6x6: Truck, Pipeline Construction, M756A2; Truck, Tank, Fuel Servicing, 1,200-Gallon, M49, M49A1C, M49A2C, M49C

9-2320-209-20	Organizational Maintenance Manual for 2 1/2-Ton, 6x6: Truck, Pipeline Construction, M756A2; Truck, Tank, Fuel Servicing, 1,200-Gallon, M49, M49A1C, M49A2C, M49C
9-2320-209-20P	Organizational Maintenance Repair Parts and Special Tools List for 2 1/2-Ton, 6x6: Truck, Pipeline Construction, M756A2; Truck, Tank, Fuel Servicing, 1,200-Gallon, M49, M49A1C, M49A2C, M49C
9-2320-209-35	Direct Support, General Support, and Depot Maintenance, Cab, Chassis, and Body Components for 2 1/2-Ton, 6x6: Truck, Pipeline Construction, M756A2; Truck, Tank, Fuel Servicing, 1,200-Gallon, M49, M49A1C, M49A2C, M49C
9-2320-209-35P	Direct Support, General Support, and Depot Maintenance Repair Parts and Special Tool Lists for 2 1/2-Ton, 6x6: Truck, Pipeline Construction, M756A2; Truck, Tank, Fuel Servicing, 1,200-Gallon, M49, M49A1C, M49A2C, M49C
9-2330-208-15	Operator, Organizational, Field, and Depot Maintenance Manual for Semitrailer, Tank: Fuel Servicing, 5,000-Gallon, 4-Wheel, M131A3C, FSN 2330-533-3380; Semitrailer, Tank, Gasoline, 12-Ton, 4-Wheel, M131, FSN 2330-835-8565, M131A1, FSN 2330-508-1484, and M131A2, FSN 2330-547-7964
9-2330-208-24P	Organizational and Field Maintenance Repair Parts Special Tools Lists for Semitrailer, Tank: Fuel Servicing, 5,000-Gallon, 4-Wheel, M131A3C,

	FSN 2330-533-3380; Semitrailer, Tank: Gasoline, 12-Ton, 4-Wheel, M131, FSN 2330-835-8565, M131A1, FSN 2330-508-1484, and M131A2, FSN 2330-574-7964
9-2330-272-14	Operator, Organizational, Direct and General Support Maintenance Instructions with Repair Parts and Special Tool Lists for Semitrailer, Tank, Fuel, 5,000-Gallon, 4-Wheel, M131A4, FSN 2330-994-9454; Semitrailer, Tank Fuel Servicing, 5,000-Gallon, 4-Wheel, M131A4C, FSN 2330-994-9458; and Semitrailer, Tank Fuel, 5,000-Gallon, 4-Wheel, M131A5, FSN 2330-226-6079
10-200	Pipefitting
10-500	Airdrop of Supplies and Equipment: General Information for Rigging Airdrop Platforms
10-500-55	Airdrop of Supplies and Equipment: Rigging Typical Supply Loads of POL and Rations for High Velocity Drop
10-500-64	Airdrop of Supplies and Equipment: Rigging Remote Area Refueling Systems
10-1101	Petroleum Handling Equipment and Operations
10-1105	Inspecting and Testing Petroleum Products
10-1109	Organizational Maintenance Military Petroleum Pipelines, Tanks, and Related Equipment
10-1112	Military Petroleum Pipeline System: Scheduling and Dispatching

10-1113	Petroleum Tank Vehicle Operation
10-1115	Pumping Assembly, Flammable Liquid, Bulk-Transfer, Gasoline-Engine-Driven, 225-GPM (Renown Stove Model 5-14-122 and Gary Steel Model 3307B)
10-1118	Petroleum Terminal and Pipeline Operations
10-1119	Airmobile Aviation Fuel Laboratory (To Be Published)
10-1158	Petroleum Testing Kit
10-1160	Petroleum Laboratory Mobile, Semitrailer Mounted
10-1161	Petroleum Base Laboratory Assembly
10-1163	ASTM Manual for Rating Motor, Diesel, and Aviation Fuels
10-1165	Significance of ASTM Tests for Petroleum Products
10-1166	The 1971 Book of ASTM Standards: Part 17, Petroleum Products - Fuels; Solvents; Engine Tests; Burner Fuel Oils; Lubricating Oils; Cutting Oils; Lubricating Greases; Hydraulic Fluids
10-1167	ASTM Standards, Part 18: Petroleum Products - Measurement and Sampling Liquefied Petroleum Gases, Light Hydrocarbons, Plant Spray Oils, Aerospace Materials Sulforates, Crude Petroleum Wax, and Graphite
10-1619	Quartermaster Materials Handling Equipment
10-4320-201-25P	Organizational, Direct Support, General Support, and Depot Maintenance Repair Parts and

	Special Tools Lists: Pumping Assembly, Flammable Liquid, Bulk Transfer, Gasoline-Engine-Driven, 225-GPM (Renown Stove Model 5-14-122) (Army Model SPE18) FSN 4320-377-9088
10-4320-202-15	Operator, Organizational, Direct Support, General Support, and Depot Maintenance Manual: Pumping Assembly, Flammable Liquid, 50-GPM (Barnes Model 9117CA) (Army Model SPE16) FSN 4320-728-0265; (Barnes Model 15671CA) (Army Model SPE16A) FSN 4320-658-2888; (Barnes Model 4074CA) FSN 4320-271-1858
10-4320-202-23P	Organizational, Direct Support, General Support and Depot Maintenance Repair Parts and Special Tool Lists: Pumping Assembly, Flammable Liquid, Bulk Transfer, 50-GPM (Barnes Model 9117CA) (Army Model SPE16) FSN 4320-728-0265; (Barnes Model 15671CA) (Army Model SPE16A) FSN 4320-658-2888; (Barnes Model 4074CA) FSN 4320-271-1858
10-4930-201-13	Operator, Organizational, and Field (Third Echelon) Maintenance Manual: Pump, Dispensing, Hand-Driven with 20-Ft. Hose, 15-GPM
10-4930-201-23P	Organizational and Field (Third Echelon) Maintenance Repair Parts and Special Tools Lists: Dispensing Pump, Hand-Driven, Piston-Type, with 20-Ft. Hose, 15-GPM (Tokheim Model 1117) FSN 4930-276-0087
10-4930-202-15	Operator, Organizational, Field, and Depot Maintenance Manual: Fuel Supply Unit, Trailer-Mounted, MX-2773/USD-1

	(FSN 5895-677-4121) for Use with Airborne Drone Surveillance System AN/USD-1
10-4930-203-13	Operator, Organizational and Direct Support Maintenance Manual: Fuel System, Supply Point, Six Fuel and Oil Servicing Nozzles, 60,000-Gallon Capacity, with Two Pumps, Two Filter-Separators, Six Loading Standards, and Six Collapsible Fabric Tanks, FSN 4930-542-2518
10-4930-203-23P	Organizational and Direct Support Maintenance Repair Parts and Special Tool Lists: Fuel System, Supply Point, Six Fuel and Oil Servicing Nozzles, 60,000-Gallon Capacity, with Two Pumps, Two Filter-Separators, Six Loading Standards, and Six Collapsible Fabric Tanks, FSN 4930-542-2518
10-4930-204-15	Operator, Organizational, Direct and General Support and Depot Maintenance Manual Including Repair Parts List: Tank and Pump Unit, Liquid Dispensing, for Truck Mounting (United Manufacturing and Engineering Model Style 1) FSN 4930-542-2800, (Model 2519) FSN 4930-987-8576, (Model 2938) FSN 4930-078-4939; (Bowser Inc., Model 36W50) FSN 4930-078-4938; (Orr and Sembower Model BL-100) FSN 4930-926-3692; (Altech Model 4000) FSN 4930-926-3581
10-4940-201-10	Operator's Manual: Cleaning Machine, Fuel Can and Drum (Barnes Model 4310CA) (Army Model SPE 19) FSN 4940-268-9771; (Barnes Model 15801CA) (Army Model SPE 19A) FSN 4940-658-2889

10-4940-201-20	Organizational Maintenance Manual: Cleaning Machine, Fuel Can and Drum (Barnes Model 4310CA) (Army Model SPE 19) FSN 4940-268-9771; (Barnes Model 15801CA) (Army Model SPE 19A) FSN 4940-658-2889
10-4940-201-25P	Organizational, Direct Support, General Support, and Depot Maintenance Repair Parts and Special Tool Lists: Cleaning Machine, Fuel Can and Drum (Barnes Model 4310CA) (Army Model SPE 19) FSN 4940-268-9771; (Barnes Model 15801CA) (Army Model SPE 19A) FSN 4940-658-2889
10-4940-201-35	Field and Depot Maintenance Manual: Cleaning Machine, Fuel Can and Drum (Barnes Model 4310CA) (Army Model SPE 19) FSN 4940-268-9771; Barnes Model 15801CA) (Army Model SPE 19A) FSN 4940-658-2889
10-7200-200-23	Organizational and Direct Support Maintenance Manual Including Repair Parts and Special Tool Lists: Can, Gasoline, Military, Steel, 5-Gallon, FSN 7240-222-3088
10-8110-201-14	Operator, Organizational, Direct Support and General Support Maintenance Manual Including Repair Parts List: Drum Fabric, Collapsible, Liquid Fuel, 500-Gallon Capacity (Nonvented) MDL 4C-135-03562, FSN 8110-753-4892, and MDL 5-14-191-1, FSN 8110-824-1444
11-337	Telephone Sets TA-43/PT and TA-263/PT

11-610	Operation and Organizational Maintenance: Radio Set AN/PRC-21
11-2059	Telephone TP-9 and Telephone Set TA-264/PT
11-2215	Teletypewriters TT-5/FG and TT-6/FG
11-5805-201-12	Operator and Organizational Maintenance Manual Including Repair Parts and Special Tools Lists: Telephone Set TA-312/PT
11-5815-204-10	Operator's Manual: Radio Teletypewriter Sets AN/GRC-46, AN/GRC-46A, AN/GRC-46B, AN/GRC-46C, and AN/VRC-29
11-5815-204-20	Organizational Maintenance Manual: Radio Teletypewriter Sets AN/GRC-46, AN/GRC-46A, AN/GRC-46B, and AN/VRC-29
11-5815-204-20P	Organizational Maintenance Repair Parts and Special Tool Lists: Radio Teletypewriter Sets AN/GRC-46, AN/GRC-46A, AN/GRC-46B, and AN/VRC-29
11-5820-398-12	Operator and Organizational Maintenance Manual Including Repair Parts and Special Tool List: Radio Set AN/PRC-25 (Including Receiver-Transmitter, Radio RT-505/PRC-25)
11-5820-667-ESC	Equipment Serviceability Criteria for Radio Set AN/PRC-77
11-5820-667-12	Operator's and Organizational Maintenance Manual Including Repair Parts List: Radio Set AN/PRC-77 (Including Receiver-Transmitter, Radio PT-841/PRC-77)

38-250	Packaging and Materials Handling: Packaging and Handling of Dangerous Materials for Transportation by Military Aircraft (AFM 71-4; DSAM 4145.3; NAVSUP Pub 505; MCO P 4030.19)
38-750	The Army Maintenance Management Systems (TAMMS)
38-750-1	The Army Maintenance Management System (TAMMS) Field Command Procedures

10. TECHNICAL BULLETINS*

(When technical bulletins cannot be obtained through regular publication supply channels, submit requests to

U.S. Army Adjutant General
Publications Center
1655 Woodson Road
St. Louis, MO 63114)

ENGINEERS

5-4200-200-10	Hand Portable Fire Extinquishers Approved for Army Use
404	Repairs and Utilities: Repairs to Fuel Oil Tanks

ORDNANCE

ORD 1031	Purging, Cleaning, Inspecting, and Coating Interior of Steel Tanks and Equipment on Tactical and Commercial-Type Fuel Tank Trucks and Trailers

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* Reference: DA Pamphlet 310-4, Index of Technical Manuals, Technical Bulletins, Supply Manuals (7, 8, and 9), Supply Bulletins, and Lubrication Orders.

793

STANDARDIZATION OF INTERNATIONAL MATERIEL

34-9-25	Code Numbers for the Identification of Fuels, Lubricants, and Allied Products used by NATO Armed Forces
34-9-45	Pumping Assembly, Flammable Liquid, Bulk Transfer, Gasoline-Engine-Driven, 225-GPM
34-9-60	Bulk Storage Tanks, Bolted, Steel, Semi-Permanent: 250-, 50[illegible], 1,000-, 3,000-, and 10[illegible]-Barrel Capacity
(0) 34-9-63	Quality and Reliability Assurance: Fuels for NATO Pipeline Network Central European Theater (AFR 74-13)
34-9-78	Hose Couplings for Petroleum Distribution in the Field

TRANSPORTATION

55-6650-300-15	Spectrometric Oil Analysis
55-9150-200-25	Engine and Transmission Oils, Fuels, and Additives for Army Aircraft

MARKING AND PACKAGING OF SUPPLIES

746-93-1	Color and Marking of Military Vehicles, Construction Equipment, and Materials Handling Equipment
746-93-2	Painting and Marking of Army Aircraft

11. SUPPLY CATALOGS AND BULLETINS*

(When supply catalogs and bulletins cannot be obtained through regular publication supply channels, submit requests to

U.S. Army Adjutant General
Publications Center
1655 Woodson Road
St. Louis, MO 63114)

SC 4230/40-IL	Decontaminating and Impregnating Equipment
C 4310-IL-A	Compressors and Vacuum Pumps
C 4320/30-IL-A	Power and Hand Pumps
C 4710-IL-A	Pipe and Tube
C 4720-IL-A, Vols. I and II	Hose and Tubing, Flexible
C 4730-IL-A, Vols. I and II	Fittings and Specialties: Hose, Pipe, and Tube
SC 4930-IL	Lubrication and Fuel Dispensing Equipment
SC 5420/30-IL	Bridges, Fixed and Floating
C 6630/40-IL	Chemical Analysis Instruments, Laboratory Equipment and Supplies
SC 6640-97-CL-E01	Laboratory, Airmobile, Aviation Fuel (FSN 6640-902-9711) (Line Item L 33184)
SC 6640-97-CL-E02	Laboratory, Petroleum, Semi-trailer Mounted (FSN 6640-538-2736) (Line Item L 33800)
C6800-IL	Identification List: Chemicals and Chemical Products

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* References: DA Pamphlet 310-6, Index of Supply Catalogs and Supply Manuals (Excluding Types 7, 8, and 9) and C-1 (Army), Introduction to Federal Supply Catalogs.

C9100-IL	Identification List: Fuels, Lubricants, Oils, and Waxes
C-ML-A	Army Management Data List
SB 710-2	Supply Control: Combat Consumption Rates for Ground and Aviation Type Petroleum Products

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12. BLANK FORMS*

(The proper source of blank forms depends on the location of the requester. When forms cannot be obtained through regular supply channels, requests from First Army, MDW, USAREUR, USARSO, Puerto Rico, Bermuda, West Indies, Greenland, Labrador, Newfoundland, and Central and Eastern Canada should be submitted to

U.S. Army Adjutant General
Publications Center
2800 Eastern Blvd.
Baltimore, MD 21220

Requests from Fifth Army, Sixth Army, USARHAW, USARJ, USARYIS, USARAL, and Western Canada should be submitted to

U.S. Army Adjutant General
Publications Center
1655 Woodson Road
St. Louis, MO 63114)

DA 272	Register of Vouchers to Stock Record Account
DA 285	Accident Report
DA 285-1	Accident Report (Continuation Sheet)
DA 285-2	Accident Report Coding and Key Punch Sheet

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* Reference: DA Pamphlet 310-2, Index of Blank Forms.

DA 444	Inventory Adjustment Report
DA 1051	Report of Injury
DA 1296	Stock Accounting Record
DA 1297	Title Insert (Formal Accountability)
DA 1298	Due Out Record
DA 1300-1	Demand Summary Card
DA 1300-2	Computation Card
DA 1300-3	Summary Accounting Transfer Record of Supply Item
DA 1300-4	Reorder Point Record
DA 1687	Notice of Delegation of Authority-Receipt for Supplies
DA 1804	Petroleum Sample Tag
DA 2077	Petroleum Products Laboratory Analysis Report
DA 2407	Maintenance Request
DA 2407-1	Maintenance Request (Continuation Sheet)
DA 2634-R	Quarterly Petroleum Products Status and Program Feeder Report (LRA)
DA 2714	CONUS Requirements for Petroleum Products
DA 2765	Request for Issue or Turn-In
DA 2765-1	Request for Issue or Turn-In
DA 3161	Request for Issue or Turn-In
DA 3253	Used Oil Sample Information

DA 3254-R	Oil Analysis Suspect Component Data (LRA)
DA 3643	Daily Issues of Petroleum Products
DA 3644	Monthly Abstract of Issues of Petroleum Products and Operating Supplies
DA 10-234	Petroleum Products--Tank Farm Intake Record
DA 10-235	Petroleum Products--Tank Farm Outturn Record
DA 10-236	Petroleum Products--Pump Station Hourly Operations Record
DA 10-238	Petroleum Products--Package Area Inventory
DA 10-241	Petroleum Products--Pump Station Operations Log
DA 10-242	Petroleum Products--Pipeline Leakage Report
DD 6	Report of Packaging and Handling Deficiencies
DD 200	Report of Survey
DD 250	Material Inspection and Receiving Report
DD 250-1	Tanker/Barge Material Inspection and Receiving Report
DD 531	Quarterly Petroleum Product Status and Program Report
DD 1155	Order for Supplies or Services/ Request for Quotation
DD 1175	Change of Address and Directory Record

DD 1348	DOD Single Line Item Requisition System Document (Manual)
DD 1348M	DOD Single Line Item Requisition System Document (Mechanical)
DD 1348-1	DOD Single Line Item Release/ Receipt Document
DD 1485	DOD Physical Inventory Document
DD 1486	DOD Materiel Receipt Document
DD 1487	DOD Materiel Adjustment Document
DD 1788	Bulk Petroleum Terminal Report (LRA)
SF 361	Discrepancy in Shipment Report (Short Title: DISREP)

13. ARMY FILMS, TRANSPARENCIES, AND GTA CHARTS*

(For films, the education NCO or general education development officer of the command can request loans from the command film library. For transparencies and GTA charts not available at the command training aids center, request the command's training aids management officer to submit a requisition to

Commanding General
USACONARC
ATTN: ATOPS-TNG-TSN
Ft. Monroe, VA 23351)

TF 5-1817	Construction of 10,000-Barrel Bolted Steel Tanks--Part I--Foundation, Bottom, and Sidewalls (RT: 16 Min.)
TF 5-1862	Military Pipeline Operations--Part I--Laying Pipelines (RT: 19 Min.)

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* References: DA Pamphlet 108-1, Index of Army Motion Pictures and Related Audio-Visual Aids, and U.S. Army Quartermaster School Index of Training Films.

TF 5-1863	Military Pipeline Operations--Part II--Installation and Pumping Stations (RT: 17 Min.)
TF 5-1864	Military Pipeline Operations--Part III--Operation and Maintenance of Pipeline Systems (RT: 10 Min.)
TF 5-1898	Construction of 10,000-Barrel Bolted Steel Tanks--Part II--Center Support, Deck, Valves, and Vents (RT: 9 Min.)
TF 9-2995	Principles of Hydraulic Systems (RT: 19 Min.)
TF 10-2731	Gaging and Sampling Petroleum Products (RT: 18 Min.)
TF 10-2799	Petroleum Safety Precautions (RT: 18 Min.)
TF 10-2855	POL Pier Discharge Operations (RT: 18 Min.)
TF 10-3151	Gasoline Dispenser Tank and Pump Unit--Operation and Maintenance (RT: 30 Min.)
TF 10-3205	Portable Class III Supply Point (RT: 25 Min.)
TF 10-3702	Valves, Traffic Controllers in the Pipeline (RT: 17 Min.)
TF 10-3868	Care and Use of the 500-Gallon Collapsible Drum (RT: 23 Min.)
TF 10-4299	The Fuel System Supply Point (RT: 30 Min.)

TF 10-4319	Petroleum Tank Vehicle Operations (RT: 29 Min.)
TF 10-4423	Petroleum Safety Hazards and Precautions at Unit and Organization Level (RT: 25 Min.)
TF 10-4538	Operation of the 350-GPM Centrifugal Pump (RT: 30 Min.)
TF 10-4545	Operation of the 50-GPM Petroleum Dispenser (RT: 26 Min.)
MF 5-1240	Oil Fires (RT: 46 Min.)
MF 55-5729	Spectrometric Oil Analysis (RT: 20 Min.) Color
T 10-2-1	Pipeline and Tank Farm Equipment Maintenance (1-16 Charts)
T 10-2-2	Fuel System Supply Point (1-12 Charts)
T 10-2-3	Measurement of Petroleum Products (1-22 Charts)
T 10-2-4	Installation and Operation of Tank and Pump Unit (Petroleum) (1-15 Charts)
T 10-2-5	Basic Petroleum Pipeline Operations (1-19 Charts)
T 10-2-6	Fuel Test Engine - Motor and Research Methods Cot (Petroleum Supply) (1-18 Charts)

801

T 10-2-8	500-Gallon Non-Vented Collapsible Drum (1-18 Charts)
T 10-2-9	Fire Prevention in Petroleum Operations (1-16 Charts)
T 10-2-10	Safety Precautions in Bulk Terminals (Petroleum) (1-27 Charts)
T 10-2-11	Waterfront Operations (Petroleum) (1-29 Charts)
T 10-2-12	Petroleum Tank Vehicle Operations (1-36 Charts)

14. AIR FORCE PUBLICATIONS*

(When Air Force Publications cannot be obtained through regular publications channels, submit request to

OCAMA (OCNSTT)
Tinker AFB
Oklahoma 73145)

AFR 67-141	See AR 740-25
AFR 144-3	See AR 7-3-2
AFR 144-11	Cash Sales and Reimbursable Issues of Ground Petroleum Products in Oversea Theaters
AFM 74-3	Petroleum Procurement Inspection Manual
AFM 85-16	Maintenance of Permanently Installed Storage and Dispensing Systems for Petroleum and Unconventional Fuels

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* References: AFRO-2, Numerical Index of Standard Air Force Publications, and TO 0-1-42, A Numerical Index and Requirement Table in the 42 Area.

AFM 88-12	See TM 5-848-2
AF TO 42B-1-1	Quality Control of Fuels and Lubricants
AF TO 42B2-1-9	Spectrometric Oil Analysis Program
AF TO 42B2-1-10	Spectrometric Oil Analysis Program

15. NAVY PUBLICATIONS*

(Navy publications cannot all be obtained from one source. Therefore addresses of sources from which the various listed publications can be obtained are entered following the applicable publications.)

OPNAVINST 4020.23A	See AR 703-2
NAVSUPINST 4020.6	See AR 740-25
NAVMATINST 4731.1	Navy Oil Analysis Program

(The three publications above may be obtained by submitting requests to

Supply and Fiscal Department
Code 514.32
Naval District of Washington, D.C.
Washington Navy Yard
Washington, D.C. 20390)

COMSERVLANT/PAC INST 4020.2A/ 4020.5C	COMSERVPAC/COMSERVLANT Fleet Oiler Manual

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* References: NAVPUBINST 5215.4 (Series), COMSERVLANTINST 5215.4 (Series), and Naval Supply Systems Command Pub 2002 (NAVSUP P-2002), Navy Stock List of Forms and Publications.

(The above publication may be obtained by submitting requests to

Commander
Service Force, U.S. Atlantic Fleet
U.S. Naval Base
Norfolk, VA 23511)

NAVPERS 10829-B	Military Sea Transportation Service
NAVPERS 10883-A	Fundamentals of Petroleum
NAVSHIPS 0900-016-0010	Manual for Cargo Tank Cleaning
NAVSHIPS 0901-550-0003	Naval Ships' Technical Manual: Chapter 9150, Gasoline (Aviation and Automotive) and JP-5 Fuel Systems
NAVSHIPS 0901-550-0003	Naval Ships' Technical Manual: Chapter 9550, Petroleum Fuel Stowage, Use, and Testing (FOUO)
NAVAIR 06-5-502	Handbook, Aircraft Refueling for Shore Activities
NAVFAC DM-22	Design Manual, Liquid Fueling and Dispensing Facilities
NARFP-P-12	Aeronautical Spectrometric Laboratory Manual

(The eight publications above may be obtained by submitting requests to

Commanding Officer
Naval Forms and Publications Center
5801 Tabor Ave.
Philadelphia, PA 19120)

16. MISCELLANEOUS PUBLICATIONS

API Publications and Materials Index

(API publishes its index annually. It may be obtained without charge by writing to

American Petroleum Institute
1801 K Street, N.W. (7th Floor)
Washington, D.C. 20006)

Oil Pipe Line Transportation Practices

Vol. I	Introduction to the Oil Pipeline Industry
Vol. II	Oil Pipe Line: Construction and Maintenance
Vol. III	Oil Pipe Line: Measurement and Storage Practices
Vol. IV	Oil Pipe Line: Pumping Station Operation

Crude Oil Tanks: Construction, Strapping, Gauging and Maintenance

(The above and other petroleum related publications may be purchased from

Petroleum Extension Service
University of Texas
Box S, University Station
Austin, TX 78712)

Laws of the United States Relating to Water Pollution Control and Environmental Quality

(The publication above may be purchased for $1 from

Superintendent of Documents
Government Printing Office
Washington, D.C. 20402)

National Oil and Hazardous Substances Pollution Contingency Plan.

(This publication is not prepared in sufficient copies for all petroleum personnel. It is needed only by persons concerned with planning pollution-abatement actions related to spills of oil or hazardous materials. Single copies can be obtained by these persons from

Division of Oil and Hazardous
Materials
Environmental Protection Agency
Washington, D.C. 20460)

PART TWO

GLOSSARY

INTRODUCTION. Part Two of this special text, the glossary, is a collection of the more common terms and abbreviations used by the petroleum industry and in military petroleum operations. The glossary is divided into two sections: Section I, Terms, and Section II, Abbreviations. The glossary is not a comprehensive list of all petroleum terms but it does include frequently used terms and some less familiar technical definitions. The abbreviations include military and industrial petroleum abbreviations. Since refinery techniques and operations are not military functions, references to terms and abbreviations used by the refining industry are limited.

SECTION I

TERMS

Absolute Pressure. Pressure measured with respect to zero pressure, as distinct from pressure measured with respect to some standard pressure, such as atmospheric pressure; 30 pounds per square inch pressure is equivalent to 44.7 pounds per square inch absolute pressure.

Absolute Viscosity. See **Viscosity, Absolute**.

Accelerated Gum Test. A test to determine the amount of gum and lead precipitate formed in aviation fuels as a result of accelerated oxidation or aging; potential gum is the amount of residue obtained by evaporating the fuel at the end of the specified aging period after any lead deposits have been removed (ASTM D-873).

Accountable Officer. An individual, either civilian or military, required to assure that accurate recording of property transactions is accomplished and current records pertaining thereto are maintained. (Accountability is concerned primarily with records, while responsibility is concerned primarily with custody, care and safekeeping.) (See also **Responsible Officer**.)

Acid. A chemical compound usually having a sour taste and capable of neutralizing alkalis and turning blue litmus paper red.

Acidity. The amount of free acid in a substance.

Additive. An agent used for improving existing characteristics or for imparting new characteristics to certain petroleum products.

Air Agitation. A method of extinguishing or controlling tank fires by injecting air or steam at the bottom inlet; the principle involved is that of cooling the product by circulation.

Air-Fuel Ratio. The ratio of the weight of air to the weight of fuel used in an internal combustion engine or furnace; the ratio in a gasoline engine is about 12-15 to 1.

Air Test. A method used to test a pipeline when a water test is not possible or desirable; the line is sectionalized by block valves and tested in lengths that depend upon the capacity of available compressors; likely to create a hazardous condition from flammable mixtures in lines that have been used for volatile products.

All-Levels Sample. A sample taken by lowering a closed sampler to the drawoff level of a tank, opening the sampler, and raising it at such a rate that it is nearly, but not quite, full when it emerges from the liquid.

Alongside Aircraft Fuel Delivery. The transportation of government-owned fuel from a storage facility, and its delivery into the fuel tanks of an aircraft. Charges for this service do not include the cost of the fuel.

Aluminum Oleate. A soap used in grease making.

American Chemical Society (ACS). A professional society of chemists which formulates specifications and establishes standards for analytical reagents used in the laboratory. A product designated ACS, a purity designation, meets all requirements of the society.

American Melting Point. An arbitrary temperature of 3° F. above the ASTM paraffin wax melting point (ASTM Method D-87). The latter is also known as the English melting point. (See *Melting Point*.)

American Petroleum Institute (API). The institute represents and is supported by the petroleum industry. It standardizes the tools and equipment used by the industry and promotes the advancement of research in the petroleum field.

American Society for Testing and Materials (ASTM). A national technical society which has among its functions the standardization of specifications and methods of testing. The organization is widely recognized as the authority on methods of testing petroleum products.

Aneroid Barometer. A barometer in which the action of the atmospheric pressure in bending a metal surface is made to move a pointer.

Anhydrous. Free of water, especially water of crystallization.

Aniline Point. The minimum temperature for complete miscibility of equal volumes of aniline and the sample under test. ATSM Method D-611 describes procedures for determining aniline point and mixed aniline point of petroleum products and hydrocarbon solvents. A product of high aniline point will be low in aromatics and naphthenes and, therefore, high in paraffins. Aniline point is often specified for spray oils, cleaning solvents, and thinners, where effectiveness depends upon aromatic content. In conjunction with API gravity, the aniline point may be used to calculate the net heat of combustion of aviation fuels.

Anode. See Electrode.

Antifoam Agent. An additive used in some lubricating oils for controlling foam.

Antiknock. Resistance to detonation or pinging in spark-ignition engines.

Antiknock Agent. A chemical compound such as tetraethyl-lead which, when added in small amounts to the fuel charge of an internal-combustion engine, tends to lessen knocking.

Antioxidant. A chemical added to gasoline, lubricating oil, and certain other petroleum products to inhibit oxidation.

API Gravity. (Also see Specific Gravity.) An arbitrary scale expressing the gravity or density of liquid petroleum products. The measuring scale is calibrated in terms of degrees API. The gravity of any petroleum product is corrected to 60° F. It may be calculated in terms of the following formula:

$$\text{Degrees API gravity at } 60^\circ\ \text{F.} \quad \frac{141.5}{\text{sp. gr.}} - 131.5$$

Apparent Viscosity. The ratio of shear stress to shear rate of a non-Newtonian fluid, such as lubricating grease, calculated from Poiseuille's equation and measured in poises. Apparent viscosity is determined by forcing a grease sample at predetermined flow rates through a series of 8 capillaries and observing the pressures developed in the apparatus.

Appearance. Refers to the visual examination of fuels. Terms used to describe appearance are bright and clear, hazy, and cloudy.

Aromatic (noun). One of a broad class of unsaturated hydrocarbons that is characterized by the ring structure of its molecules.

Aromatic (adjective). Derived from, or characterized by, the benzine ring.

Ash Content. The percent by weight of residue left after combustion of a sample of fuel oil or other petroleum oil. In the United States, ash content is usually determined by ASTM Method D-482.

Asphalt. Black to brown solid or semisolid cementitious material which gradually liquefies when heated and in which the predominating constitutents are bitumens. It occurs in nature or is obtained as a residue from cracked stocks or from the distillation of certain crude oils.

Assault Hoseline System. A petroleum hoseline system composed of hose, collapsible fuel cells, and portable pumps which can be readily installed to supply fuel to rapidly advancing combat areas.

ASTM. (See American Society for Testing and Materials.)

ASTM-CFR Engine. A special engine developed by the Coordinating Fuel and Equipment Research Committee of the Coordinating Research Council, Inc., to determine the knock tendency of gasolines.

Atmospheric Pressure. 1. The pressure of air; more specifically, the pressure of the air at sea level. 2. As a standard, the pressure at which the mercury barometer stands at 760 millimeters or 30 inches (equivalent to approximately 14.7 pounds per square inch).

Atmospheric Tank. A storage tank, either flat or cone-roofed, designed primarily for the storage of low-vapor-pressure products. The tank, which may be of bolted, riveted, or welded construction, is not intended to withstand appreciable pressure or vacuum.

Atom. The smallest complete particle of an element which can be obtained that retains all physical and chemical properties of the element. According to present theory, the atom consists of a nucleus of protons and neutrons positively charged, surrounded by negatively charged particles called electrons.

Autogenous Ignition Temperature. The temperature of a metal bath just adequate to cause ignition of a mixture of petroleum or similar vapor and air when tested in accordance with the provisions of ASTM Method D-2155-66.

Autoignition. The spontaneous ignition, and the resulting very rapid reaction, of a portion of all of the air-fuel mixture in an engine. The flame speed is many times greater than that which follows normal spark ignition. The noise associated with it is called knock.

Automotive Gasoline (MOGAS). A hydrocarbon fuel in the approximate composition range $C_5 H_{12}$ to $C_9 H_{20}$ for use in internal combustion engines and procured by the military under two specifications. Federal Specification VV-G-76 provides for two grades, regular and premium, and for three classes, A, B, and C. Specification MIL-G-3056 specifies combat grade types I and II.

Average Boiling Point. The sum of the ASTM distillation temperatures from the 10-percent point to the 90-percent point, inclusive, divided by 9. Sometimes half the initial and half the maximum distillation temperatures are also added, and the sum then divided by 10.

Average Sample. A sample so taken as to contain parts from all sections of a container or pipe, in proportion to the volume of each part.

Aviation Fuels (AVFUELS). Those refined petroleum products specifically formulated and blended for use in aircraft engines, both jet (reaction) engines and piston (reciprocating) engines. AVGAS (below) is an aviation fuel.

Aviation Gasoline (AVGAS). A hydrocarbon fuel for use in reciprocating piston-type aircraft engines and characterized by low vapor pressure and distillation range and high tetraethyllead content. It is procured by the military under Specification MIL-G-5572, which provides for three grades: 80/87, dyed red; 100/130, dyed green; and 115/145, dyed purple.

Bacon Bomb. A thief-type sampler, also called a tank-car thief, consisting of a special metal cylinder tapered at both ends and fitted internally with a plunger valve that opens automatically when the sampler strikes the bottom of the tank car. A trip cord may be attached to make it possible to open the cylinder at any desired depth. The sampler is used in storage tanks and tank cars to take bottom samples of liquid products of 2 p.s.i., or less, Reid vapor pressure, and samples of semiliquid products. (See Sampler.)

Balanced Gasoline. A motor fuel blended from components with high, intermediate, and low volatility in such proportions as to produce a desirable compromise among performance qualities (easy starting, warmup, acceleration, mileage) that depend upon the relative volatility of the components.

Balloon Roof Tank. A tank with a flexible steel diaphragm at the top of the shell and beneath a bulging roof that extends beyond the shell. The diaphragm flexes upward or downward, thus providing a variable vapor space which eliminates some breathing losses. The tank is used primarily for the storage of volatile products.

Barge. A roomy, flat-bottomed boat used to carry cargo on inland waters or in lighterage service. Barges are normally towed. An oil barge is designed with covered tanks to transport liquid cargo. (See Tanker and Y-Boat.)

Barium-Base Grease. A water-resistant grease with high heat stability made by thickening a petroleum oil with a barium soap.

Barometer. See Aneroid Barometer.

Barrel (bbl.). A common unit of measurement of liquids in the petroleum industry. It equals 42 U.S. standard gallons.

Base Terminal. The initial facility for receiving, storing, and distributing petroleum products entering a theater of operations.

Batch. A quantity of product pumped into a pipeline in a continuous operation.

Batch Change. Change or transition from one product to another in a pipeline, as evidenced by a change in product color or gravity or both.

Batching. The determination of the sequence in which two or more products are to be pumped and the introduction of those products into the pipeline in that sequence, arranged with the least waste of interfacial material.

Bath, Laboratory. An outer vessel supported over a source of heat containing sand, water, salt, or other substance in which an inner vessel is partly submerged. The inner vessel contains the material to be heated, and the substance in which the vessel is submerged distributes the heat evenly.

Beaker. A cylindrical glass vessel with straight sides, a flaring rim, and pouring lip used in the laboratory.

Bend. A curved length of pipe struck to a larger radius than a pipe elbow or ell. Pipe bends of 45°, 90°, or 180° are often specified as one-eighth, one-quarter, or one-half bends. A slight bend is often called a spring.

Bending Machine. A device for bending lengths of pipe to make horizontal or vertical changes in direction of the pipeline.

Benzene. Colorless liquid hydrocarbon, C_6H_6, with one ring of carbon atoms. Made from coal tar and by catalytic reforming of naphthenes, it is used in the manufacture of various products, as a solvent, and as a component of high-octane gasoline.

Benzol. The general term which refers to commercial or technical benzene.

Bernoulli Theorem. The proposition that in a flowing stream the sum of the pressure head, velocity head, and elevation head at any point is equal to their sum at any point downstream plus the friction head loss between the points.

Bitumen. A mixture of hydrocarbons of natural or pyrogenous origin, or both, frequently accompanied by their nonmetallic derivatives, and which are completely soluble in carbon disulfide.

Black Oils. Black oils, when referred to in tanker or barge cargo, or in bulk transfers, are those usually classed as boiler fuels or burner fuels. (They do not, of course, include diesel fuels.)

Bladder Bird. See Flying Cow.

Blank. See Figure-Eight Blank.

Blank Flange. A pipe-connecting flange supplied without bolt holes, but otherwise ready for use; the fitting is intended to be drilled to suit the application; not the same as a blind flange.

Bleeding. 1. Diverting a small portion of the material contained in a line or vessel, usually by opening a valve slightly. 2. Separation of liquid lubricant from a lubricating grease.

Blending. 1. Mixing refinery products to suit market conditions. 2. Mixing on-specification fuel with off-specification fuel to bring the latter within use limits (a method of reclamation). 3. Mixing an interface with either or both adjacent products, or with a third product, without degrading any of them beyond use limits.

Blending Kit. The portable CFR blending kit (FSN 6640-738-2125); provides a convenient method of blending three reference or standardization fuels in small quantities as needed.

Blending Tolerance. 1. The percentage of one product that can be blended with, or tolerated by, a second product without throwing the second product so far off specification as to be beyond use limits. 2. The practice of dividing interfaces between adjacent products.

Blind Flange. A flange used to close the end of a pipe or to close a pipeline to produce a dead end; used to insure that there will be no movement of product; not the same as a blank flange.

Block Valve. Any valve in the main line of a pipeline, used to sectionalize a line.

"815"

Bloom. Fluorescence; the color of an oil by reflected light when this differs from its color by transmitted light. For certain purposes the trade has preferred oils of yellowish-green rather than bluish-green bloom. This demand can be met by special processing.

Blow-By. The escape of combustion gases or unburned fuel from the combustion chamber past the pistons and rings into the crankcase in internal-combustion engines, during the power stroke or the compression stroke.

Body. A colloquial term referring to the viscosity of a lubricating oil.

Boiling Point (b.p.). The temperature at which a substance boils or is converted into vapor by bubbles forming within the liquid. The temperature varies with atmospheric pressure.

Boiling Range. The range of temperature, usually determined at atmospheric pressure in standard laboratory apparatus, over which the boiling or distillation of an oil commences, proceeds, and finishes.

Bolted Tank. A semipermanent, prefabricated storage tank. The plates of the tank shell are bolted together rather than welded or riveted. Military bolted tanks have capacities of 100, 250, 500, 1,000, 3,000, and 10,000 barrels.

Bomb. A steel cylinder used as a device for conducting petroleum tests under high pressure, e.g., in gum, sulfur, and Reid vapor pressure tests.

Bonding. Electrically connecting units or containers before operations begin, to equalize any static potential that might exist and to provide a continuous path for any static potential that might be generated after operations begin. (See **Grounding**.)

Booster Station. A pump station used to boost the discharge from tanker pumps to base-terminal storage, or used along the pipeline for added throughput.

Bottled Gas. Ordinarily, butane or propane, or butane-propane mixtures, liquified and bottled under pressure. (See **Liquified Petroleum Gas**.)

Bottom Loading. Refers to the loading of a railway tank car or tank vehicle through the bottom outlet. During bottom loading a closed system is maintained, reducing the loss of vapors and dangers of static ignition.

Bottom Sample. A sample taken with a Bacon bomb or thief sampler from material at the bottom of a tank. (See Bacon Bomb.)

Bottom Sediment and Water (BS&W). Amount of sediment and water measured in the bottom of a tank.

Bottom Settlings. The heavy material that collects in the bottoms of storage tanks consisting principally of water and sediment. (See Bottom Sediment and Water.)

Bracketing. The grading of the antiknock quality of an unknown sample between two reference fuels, one slightly better and the other slightly worse than the unknown sample as indicated by the knockmeter. The octane number of the unknown sample of gasoline is then obtained from a calibration table.

Branch Station. A pump station on a branch or lateral pipeline.

Breakout Tankage. Storage tanks utilized by pipeline operators for intermediate storage in order to facilitate product deliveries.

Breather-Roof Tank. A variable-vapor-space tank similar to a baloon-roof tank except that the bulging roof does not extend beyond the tank shell.

Breathing. The movement of gas (product vapors or air) in and out of the vent lines of storage tanks as a result of alternate heating and cooling.

Bright. (See Clean and Bright.)

British Thermal Unit (B.t.u.). The quantity of heat required to raise by 1° F., the temperature of 1 pound of water at its maximum density (39.2° F.).

Bubble Point. The first visible sign of vaporization in the distillation test. It occurs just before the initial boiling point, or when the first drop of liquid falls from the condenser (ASTM Method D-86).

Buffer. A product pumped into a pipeline to separate products that differ too greatly in quality or gravity; the buffer prevents the formation of an interface that cannot be disposed of readily.

Bulk Petroleum Products. Those petroleum products (fuels, lubricants, etc.) which are normally transported by pipeline, rail tank car, tank truck, barge or tanker and stored in tanks or containers having a capacity of more than 55 gallons, with the exception that fuels in 500-gallon collapsible containers are considered to be packaged. (See Packaged Petroleum Fuels.)

Bulk Reduction. Packaging bulk petroleum products in cans, drums, and 500-gallon collapsible containers.

Buna N. See Nitrile Rubber.

Bunker C Fuel Oil. A heavy residual fuel oil used by ships, industry, and for large-scale heating installations. The Navy calls it Navy Heavy; industry often refers to it as No. 6 fuel.

Bunkering Fuel. A fuel oil carried by ships for their own use.

Burette. A graduated glass tube with a stopcock, used in the laboratory for measuring solutions in titration.

Burner Fuel Oil. A fuel oil used under boilers and in furnaces to generate power or heat. Under Federal Specification VV-F-815, it is produced in six grades: FS No. 1, FS No. 2, FS No. 4, FS No. 5 (Light), FS No. 5 (Heavy), and FS No. 6. Under Specification MIL-F-859, one grade, Navy special, is produced.

Burning Oil. An illuminating oil such as kerosene, mineral seal oil, etc., of such gravity and degree of cleanliness that it may be burned through a wick. (See Kerosene.)

Burning Point. See Fire Point.

Burning Quality. Refers generally to burning characteristics of fuels used in lamps, stoves, ranges, and space heaters; refers particularly to kerosene (ASTM Method D-187).

Bushing. A hollow pipe fitting with both internal and external threads; used to connect pipes or pipes and fittings of different diameters.

Butane. Either of two isomeric, flammable, gaseous hydrocarbons, $C_4 H_{10}$, of the paraffin series, n-butane or isobutane. Bottled, butane is referred to as LPG and is used for domestic and laboratory purposes and for general brazing.

Butterworth. A commercially developed method of cleaning and gas-freeing tanker cargo tanks with hot salt water sprayed from a special machine at about 175 pounds per square inch and 175° F.

Butt Weld. A weld between two abutting ends or edges without overlapping.

Bypass. A means of diverting flow of fluid in a system past some part of the system through which the fluid normally flows, as in conducting the stream around a pump station.

Calcium-Base Grease. A grease composed of a mineral oil thickened with calcium (lime) soaps and suitable for slow-moving machine parts. It does not retain consistency at high temperatures.

Calibration. 1. The graduation of a measuring instrument. 2. The determination of accuracy of graduation in a measuring instrument.

Calk. To seal the seams between adjacent plates or planks, generally by driving some expansive or impervious material between them.

Calorie (cal. or Cal.). 1. The amount of heat required to raise the temperature of 1 gram of water 1° C., at or near the temperature of maximum density. This unit is called a "small calorie" or "gram-calorie" and is abbreviated "cal." 2. The amount of heat required to raise the temperature of 1 kilogram of water 1° C. This unit is called a "large calorie" or "kilogram-calorie" and is abbreviated "Cal."

Calorific Value. The heat liberated by the combustion of a unit quantity of fuel, e.g., British thermal units per pound of fuel, calories per gram of fuel.

Calorimeter. An apparatus for measuring quantities of heat, such as the bomb calorimeter, which is used to determine the heat of combustion or the thermal value of a fuel in calories or British thermal units.

Capacity Table. A table showing quantities for either innage or outage gages of a storage tank.

Carbon Dioxide. A heavy, colorless gas, CO_2, which will not support combustion (therefore being useful as a fire-extinguishing agent). It is exhaled as a waste gas by lung-possessing animals and absorbed by certain plants which then release oxygen as a waste gas.

Carbon Monoxide. A colorless, odorless, and poisonous gas, CO, resulting from the incomplete combustion of carbon.

Carbon Residue. The carbonaceous residue formed after evaporation and pyrolysis of a petroleum product. The residue is not entirely composed of carbon, but is a coke which can be further changed by pyrolysis. (ATSM D-189.)

Carbon Tetrachloride. A colorless, nonflammable liquid, CCl_4, used as a solvent, a detergent, and a drying agent for electrical parts. It is no longer used as an extinguishing agent because of its toxic qualities.

Catalyst. A substance that promotes chemical action without itself undergoing chemical change.

Cathode. See Electrode.

Cathodic Protection. An electrolytic method of protecting a buried pipeline or other metal structure against corrosion by surrounding it by an electrical blanket strong enough to overpower the currents seeking to leave the metal to go into the soil. The method involves putting electrical current into the soil so that it flows to and into the line or structure. The protective current may be obtained by the galvanic action between magnesium anodes and the steel of the pipeline or structure or by a rectifier to convert alternating current to direct current, which is put into the soil through a scrap metal graphite ground-bed.

Caustic Wash. 1. The process of treating a product with a solution of caustic soda to remove minor impurities. 2. The solution itself.

Cavitation. Formation of a cavity or partial vacuum around a fan, propeller, or impeller that is revolving above a certain critical speed causing a loss of efficiency.

Centrigrade Scale. A thermometer scale on which the interval between the freezing point and boiling point of water is divided into 100 parts or degrees centrigade. Zero degrees C. corresponds to 32 degrees F., and 100 degrees C. to 212 degrees F. Also called Celsius after Anders Celsius who first described it.

Centipoise. A unit of absolute viscosity; 0.01 poise. (See Viscosity, Absolute.)

Centistoke. A unit of kinematic viscosity; 0.01 stoke. (See Viscosity, Kinematic.)

Centrifugal Pump. An apparatus that builds up pressure head using centrifugal force as the principal means and angular velocity as the secondary means. (See Pump, Centrifugal (Volute Type).)

Centrifugal Separator. A machine using centrifugal force to separate two materials of differing gravity, such as wax from oil, or acid sludge from treated oil.

Centrifuge. A whirling instrument for separating liquids or liquids and solids of different specific gravity by use of centrifugal force.

Cetane. A paraffin hydrocarbon (normal hexadecane), $C_{16}H_{34}$, used as a standard in determining or measuring the ignition qualities of diesel fuels.

Cetane Number. The percentage by volume of normal cetane (100 cetane number), in a blend with heptamethylnonane (0 cetane number), which matches the ignition quality of the diesel fuel under test when compared by the procedure specified in ASTM Method D-613. The determination of the cetane number of diesel fuel is similar to the determination of the octane number of gasoline.

Coordinating Fuel and Equipment Research Committee (CFR). This committee is composed of engine-manufacturing, petroleum-refining, petroleum-marketing, university, Government, and other technical representatives who supervise cooperative testing and study of engine fuels for the Coordinating Research Council, Inc.

CFR-ASTM Engine. See ASTM-CFR Engine.

Change of Product. Change of service; refers generally to transporting or storing a product in a vessel, tank car or vehicle, storage tank, or other container, after having transported or stored a different product previously; the difference between the two products governs the nature and extent of preparations (draining, flushing, cleaning) needed before the change can be made.

Channeling. The phenomenon observed among gear lubricants when they thicken, due to cold weather or other causes, to such an extent that a groove is formed through which the part to be lubricated moves without actually coming in full contact with the lubricant.

Cheater. A length of pipe fitted over a wrench or the handwheel of a valve to increase leverage. Using a cheater is a practice that is forbidden.

Check Valve. A one-way or nonreturn valve that permits fluids to pass in one direction only and closes when the pressure causing flow stops.

Chemical Composition. Proportions of the elements in a chemical compound; for example, methane has the formula or chemical composition CH_4, indicating that the substance is composed of four hydrogen atoms for each carbon atom.

Chemical Stability. Resistance to chemical change; indicates that the various elements present in oil or grease will not undergo change, nor will the product as a whole change as a result of action taking place within itself.

Chime. Edge or rim of drum or stave of storage tank.

Chromometer. An instrument, also called a colorimeter or tintometer, for determining the color of petroleum products. (See Colorimeter.)

Clamp, Leak Repair. A clamp supplied in one of three types for temporary repair of leaking pipe or couplings: 1. Split leak clamp consisting of a saddle, stirrups, and a gasket to be fitted around the pipe at a split; 2. Pit leak clamp used to stop a small hole caused by corrosion or other damage; 3. An overcoupling clamp in two halves, used to enclose a leaking coupling.

Clarifier. Any apparatus or device for removing the color or cloudiness of an oil by separating the foreign material through mechanical or chemical means. It may embody the principle of centrifugal action, filtration, simple heating or treatment with acid or alkali, or several of these principles.

Class III A Supplies . Packaged and bulk petroleum products used in support of aircraft.

Class III H Supplies. Bulk petroleum. Class III H includes those petroleum products that are transported in tankers, liquid-cargo barges, etc., in accordance with petroleum slating procedures.

Class III J Supplies. Packaged petroleum products. Class III J includes lubricants, greases, hydraulic fluids, etc., that have been packaged or containerized at the procurement source or are issued through petroleum supply depots or petroleum supply points.

Class III V Supplies. Packaged petroleum fuels. Class III V includes those filled containers of 500 gallons or less capacity.

Class of Fires. Class A, fires of ordinary combustibles, such as paper, wood, textiles, or rubbish, and extinguished by water. 2. Class B, fires of flammable liquids like gasoline, oil, grease, and extinguished by smothering. 3. Class C, fires involving electrical equipment, and extinguished by nonconducting agents. 4. Class D, fires involving burning metal.

Clean and Bright. Clean is the absence of visible solids, a cloud, a haze, an emulsion, or free water in the product. Bright is the sparkle of clean, dry product in transmitted light.

Clean Product. Products such as aviation and motor gasolines, jet fuel, diesel fuel, kerosene, and lubricating oil; contrasted with black oil.

Clear Gasoline. A gasoline which is free from antiknock additives such as tetraethyllead.

Cleveland Open-Cup Tester. Apparatus used for determining the flashpoints and fire points of all petroleum products flashing above 175° F., except fuel oils. Usually used as prescribed in ASTM Method D-92.

Clingage. Any residue of a product heavy enough to cling to the walls of a container after the product has been pumped or poured out. The heavier the product, the thicker and more tenacious the residue.

Closed Circuit Refueling. A system of refueling rotary-wing aircraft in which the nozzle mates with and locks into the aircraft's fuel tank, eliminating spillage.

Closed Tester. See **Flashpoint**.

Closing Gage. A volume measurement of product taken immediately after a delivery or receipt of product.

Cloud Point. The temperature at which paraffin wax or other solid substance in an oil begin to crystallize or separate, causing the oil to appear cloudy or hazy. . Cloud point is described in ASTM Method D-2500.

Coalescing. 1. Drawing together, combining, or uniting to form one body. 2. A method of separating finely divided or suspended water from a petroleum product by passing the product through filter media of a filter/separator.

Coefficient of Expansion. The ratio of the increase of length, area, or volume of a body for a given rise in temperature (usually 1° F.) to the original length, area, or volume of the body.

Coefficient of Friction. The quotient obtained when the minimum force necessary to move two solid bodies past each other (static friction) or the force necessary to keep them moving at a steady rate (sliding friction) is divided by the force pressing the solids together.

Cohesion. That force or interattraction by which molecules of the same kind or of the same body are held together so that the body resists being pulled apart.

Colorimeter. Apparatus widely used for determining the color of lubricating oil; it is described in ASTM Method D-1500. The color so determined is known as ASTM color. (See Chromometer.)

Color Stability. The resistance of oil to discoloration due to light, aging, etc.

Combustion. Burning or rapid oxidation caused by the union of oxygen and any material capable of being ignited.

Combustion Lag. The lapse of time between the ignition of the compressed charge of fuel vapors and the time when maximum pressure is developed in the combustion chamber.

Commingling. The intentional or unintentional mixing of one or more products of different ownership or grade.

Compatibility. Refers to the ability of additives or of lubricating oils of different composition or from different sources to mix together without separation or reaction.

Composite Sample. A mixture of individual samples representing the bulk from which they were taken; not the same as a mixed sample.

Compound. A substance formed by the combination of two or more ingredients, in definite proportions by weight, and possessing physical and chemical properties entirely different from those of the combining ingredients if used separately.

Compounding. The addition of fatty oils and similar materials to lubricants to impart special properties. Lubricating oils to which such materials have been added are known as compounded oils.

Compression Ignition. Ignition in a diesel engine, in which the heat of compression ignites the fuel, in contrast to the spark ignition in a gasoline engine.

Compression Pressure. The pressure of the gases in the cylinder of an internal-combustion engine at the end of the compression stroke.

Compression Ratio. The ratio of the volume enclosed in an engine cylinder at the beginning of the compression stroke to the volume at the end of the compression stroke. The higher the compression ratio the higher the efficiency and output of the engine, the greater the tendency to knock, and the greater the need for high-octane fuel.

Cone Penetration Test. ASTM Method D-217, used to measure the consistency of lubricating greases; ASTM Method D-937, usually used in the United States to measure the penetration of petrolatum as an emphirical measure of consistency.

Conradson Carbon Test. A carbon residue test originated by Dr. Pontius H. Conradson and standardized by ASTM Method D-189. (See Carbon Residue.)

Consistency. The degree to which a plastic material, such as a lubricating grease, resists deformation under the application of force. It is, therefore, a characteristic of plasticity, as viscosity is a characteristic of fluidity. Consistency is indicated by apparent viscosity; or, as in the case of grease, is measured by the penetration of a special cone into the grease under prescribed conditions of temperature, load, and time, as described in ASTM Method D-217.

Contaminant. A foreign substance in a product.

Contaminated Product. An off-specification product resulting from mixing with another product or products of different type and grade or by introduction of foreign matter such as rust, dirt, or water.

Contamination. The addition to a petroleum product of some material not normally present. Common contaminants are water, dirt, sand, rust, mill scale, and other petroleum products.

Continuous Sample. A sample taken from a flowing pipeline in such a manner that the sample is a representative average of the stream during the period of sampling.

Conversion Factor. A constant used to change or convert dimensional units into other dimensional units, such as barrels to cubic feet and inches to millimeters.

Conversion Outfit. Petroleum dispensing equipment, adapted for use in military vehicles, such as the liquid dispensing tank and pump unit for truck-mounting.

Coordinating Research Council, Inc. An organization supported jointly by the American Petroleum Institute and the Society of Automotive Engineers, which administers the work of the Coordinating Fuel and Equipment Research Committee (CFR) and other committees pertaining to correlation of test work on such things as fuels, lubricants, and engines. (See Coordinating Fuel and Equipment Research Committee.)

Copper Strip Corrosion. A qualitative method of determining the corrosivity of a product by its effects on a small strip of polished copper suspended or placed in the product (ASTM Method D-130).

Corrosion. Rusting; a gradual eating away or oxidation such as the action of moist air on steel, and the more rapid chemical action of acid on metal or steel.

Corrosion Fatigue. Metal fatigue accompanied and aggravated by corrosion.

COT Engine. Coordinated oil test engine; a portable knock test engine.

Cracking. A phenomenon by which large oil molecules are decomposed into smaller, lower boiling molecules; at the same time, certain of these molecules, which are reactive, combine with one another to give even larger molecules than those in the original stock. The more stable molecules leave the system as cracked gasoline, but the reactive ones polymerize, forming tar and even coke. Cracking may be either catalytic or thermal.

Crankcase Dilution. The contamination of the crankcase lubricating oil in an internal-combustion engine with unburned portions of the fuel which pass the piston rings and condense in the crankcase. ASTM Method D-322 describes a method of determining the amount of dilution in crankcase oils when gasoline has been used as fuel.

Critical Compression Pressure (CCP). The highest possible pressure in an air-fuel mixture before spontaneous ignition takes place.

Critical Velocity. That zone of velocities between laminar flow and turbulent flow, where the exact nature of flow is unpredictable; flow being considered laminar when the Reynolds number is less than 2,000, turbulent when the Reynolds number is greater than 4,000, and critical or indeterminate in between those values.

Crude. In a natural state; not altered, refined, or prepared for use by any process, as crude oil or crude petroleum.

Crude Oil (Petroleum). See Petroleum.

Cup-Case Thermometer. An instrument, consisting of a thermometer attached to a hardwood back, with the base of the thermometer enclosed by a metal cup, used to measure the temperature of products in storage tanks. The thermometer is lowered to the desired level, allowed to remain for a prescribed time, withdrawn suddenly, and read. The liquid-filled cup prevents a change in the height of the mercury before it can be read.

Cup Grease. A grease, usually with a lime base, originally used as a lubricant in compression cups on engine bearings. It is now made in a number of viscosity grades for numerous applications.

Cut. 1. A fraction obtained by a separation process (see Fractional Distillation). 2. Product withdrawn from a pipeline and routed into tankage; product withdrawn from the middle of a batch is referred to as a heart cut.

Cutting Oil. An oil used to lubricate and cool metal-cutting tools. Such oils may be soluble or insoluble in water.

Cylinder Oil. A viscous lubricating stock, used for lubricating the cylinders and valves of steam engines.

Damping Fluid. A fluid used to prevent, retard, or diminish vibration or movement of certain instrument components, such as that used to retard the swing of compass needles. Damping fluids are supplied in several viscosity grades.

Datum Plate. A level metal plate attached to the tank bottom directly under the reference point to provide a smooth surface for the innage bob to rest on.

Deadwood. Internal fittings and fixtures such as boltheads, channels, ladders, roof supports, and poles which occupy space within the tank and reduce storage capacity, and any tank feature projecting outside the tank that adds to tank capacity, such as cleanout doors and pipe connections.

Decanting. 1. Transferring liquid from one container to another without disturbing the sediment. 2. In military operations, transferring bulk product to containers with capacities of 55 gallons or less (normally, 5-gallon cans and 55-gallon drums).

Defense Fuel Supply Center (DFSC). An activity under the Defense Supply Agency (DSA) with responsibility as the integrated material manager (IMM) for wholesale bulk petroleum products until their delivery to the point of sale. This responsibility includes contract administration overseas.

Defense Fuel Supply Center Contract Bulletin. A publication distributed by DFSC to disseminate information concerning all contracts awarded for direct support of installations. A separate contract bulletin is published for each of several selected purchase programs, e.g., East/West Coast Marine, Regions 1 through 8, Alaska, etc.

Defense Fuel Supply Point (DFSP). Any military or commercial bulk fuel terminal storing product owned by the Defense Supply Agency.

Defense General Supply Center (DGSC). An activity, under the Defense Supply Agency (DSA) responsible for management of packaged petroleum products, exclusive of packaged fuels. (See Packaged Petroleum Fuels and Packaged Petroleum Products.)

Defense Supply Agency (DSA). The agency, at the Department of Defense level, charged with providing the most effective and economical support of common supplies and services to the military departments and other designated Department of Defense components. It is the agency under which the Defense Fuel Supply Center operates.

829

Degree of Purity. A term applied to chemical reagents used in analytical laboratories to indicate grade or quality and compliance with appropriate specification; common designations are c.p. (chemically pure), ASC (American Society of Chemists), USP (United States Pharmacopoeia) and Technical. (See Tested Purity.)

Dehydrator. Separator or segregator; an apparatus for removing water from products; operated by settling or gravitation, by centrifuging, by breaking down emulsions, or by coalescence within a filter medium.

Deliquescent. Tending to absorb liquids, particularly moisture from the atmosphere, to such an extent that the solid properties may be modified or lost.

Demulsibility. The rate of separation of the components of an emulsion. A separated emulsion is said to be demulsified. ASTM Method D-1401 is a method of determining the time required for an emulsified steam-turbine oil to separate.

Density. Specific weight or mass of a substance per unit volume (pounds per cubic foot or gallon or grams per cubic centimeter); specific gravity is the ratio of the mass of any volume of a substance to the mass of an equal volume of some standard substance (water in the case of liquids and hydrogen or air in the case of gases) at 40° C.

Department of Defense Activity Address Code (DODAAC). A distinctive six-position alpha-numeric code assigned to identify specific units, activities or organizations. This code is used for the first six positions of a MILSTRIP document number. The codes are published in DOD 4000.25-D, DOD Activity Address Directory (DODAAD).

Depressor. See Pour Depressor.

Desiccator. 1. A glass jar, fitted with an airtight cover and containing at the bottom some moisture-absorbing agent, used for storing material in a dry atmosphere. 2. An apparatus used for drying some material or substance, usually by the aid of heat and sometimes in a vacuum.

Design Fuel. Fuel of an overage specific gravity selected as a basis for designing a multiproduct pipeline. Usually,

852

the design fuel for a multiproduct pipeline is regular-grade automotive gasoline, because, under normal conditions, a line designed for this fuel can handle other fuels effectively. In a single product line, the design fuel is the product to be carried.

Desorption. The reverse process of adsorption whereby adsorbed matter is removed from the adsorbent. The term is also used as the reverse of absorption.

Detergency. The ability of a substance to clean and to wash away undesirable substances. Detergents may be either oil-soluble or water-soluble. Soap and synthetic detergents help to wet, disperse, and deflocculate solid particles. Oil-soluble detergents are used in motor oils to disperse, loosen, and remove carbon, dirt, and other undesirable materials from interior surfaces of internal-combustion engines.

Detergent Oil. A lubricating oil possessing special sludge-dispersing properties for use in internal-combustion engines. These properties are usually conferred on the oil by the incorporation of special additives. Detergent oils hold sludge particles in suspension and thus promote engine cleanliness.

Deterioration. Any undesirable chemical or physical change that takes place in a product during storage or use. Some of the more common forms of deterioration are weathering, gum formation, weakening of additives, and change in color.

Detonation. Sharp explosion. The term is used to describe the knock-producing type of combustion in spark-ignition, internal-combustion engines.

Dew Point. The temperature at which vapor starts to condense.

Diesel Engine. An internal-combustion engine in which air drawn in by the suction stroke is so highly compressed that the heat generated ignites the fuel, which is automatically sprayed into the cylinder under high pressure.

Diesel Fuel. A hydrocarbon fuel used in diesel engines. Diesel fuels used by the Armed Forces are manufactured under two specifications: VV-F-800, which provides for three grades (DF-1, -2, and -A); and MIL-F-16884, which provides for one grade (Marine).

Diesel Fuel Additive. Material added to diesel fuel to improve the ignition quality. Examples are amyl nitrate and ethyl nitrate.

Diesel Index. An expression for the ignitability of a fuel relative to its aniline point.

$$\text{Diesel index} = \frac{\text{aniline point } (^\circ\text{ F.}) \times \text{API gravity}}{100}$$

Differential Pressure. The difference between suction pressure and discharge pressure of a pump; increment of pressure added by each pump operating in series in a pump station; pressure drop or loss between the inlet and outlet of a filter, meter, or other accessory offering resistance to flow.

Diffusion. Spontaneous mixing (as opposed to mixing by mechanical means) of the molecules of two or more fluids, as in the case of gasoline vapor in air and alcohol in water.

Dike. An embankment or firewall erected around a storage tank to contain product should tank leakage or rupture occur.

Diluent. A liquid used to dilute or thin another liquid.

Direct Injection. An ignition system in which the fuel is injected directly into the cylinder or manifold instead of into a precombustion chamber.

Discharge Side. Side of pump having the discharge pressure of the product.

Dispersion. The fairly permanent suspension of finely divided (undissolved) particles in a fluid.

Dissolved Water. See Water, Dissolved.

Distillate. That portion of a liquid which is removed as a vapor and condensed during a distillation process.

Distillation. Vaporization of a liquid and its subsequent condensation in a different chamber. In refining, it refers to the separation of one group of petroleum constituents from another by means of volatilization in some form of closed apparatus, such as a still, by the aid of heat. ASTM distillation. Any distillation made in accordance with an ASTM distillation procedure; and, especially, a distillation test made on such products as gasolines, jet or turbine fuels, and kerosene to determine the initial and final boiling points and the boiling range (ASTM Method D-86).

Distillation Loss. The difference between the volume of liquid originally introduced into the distilling flask and the sum of the residue and the condensate recovered.

Distribution Plan. A summarization of contract award data prepared and published by DFSC to advise CONUS and overseas field offices and other petroleum management activities of how all requirements of a specified procurement program and delivery period will be supported.

Distribution Plan Authorization. Establishes the maximum quantity of a product which may be ordered against all contracts managed by a particular field office or Joint Petroleum Office (JPO).

Doctor Test. A qualitative test used to detect compounds in light petroleum distillates that react with sodium plumbite. The test involves combining two parts of sample and one part doctor solution (sodium plumbite), shaking, adding a pinch of pure dry sulfur, shaking again, and allowing the mixture to settle. If the sulfur film is discolored or flecked with brown or black, the sample is reported positive (or sour); if the sulfur is not discolored, the sample is reported negative (or sweet). (ASTM D-484.) (See Plumbite Solution.)

Dome Innage. The height of liquid in the dome of a railway tank car, measured from the underside of the tank-car shell at its highest point.

Downgrading. Assigning a lower grade to an off-specification product, provided it meets the requirements of the lower grade.

Drawoff Valve. A connection on a tank shell (near bottom) or tank bottom, through which water may flow or be drawn from a tank or vessel, or from a sump in the bottom of a tank or vessel.

833

Dropping Point. The temperature at which grease passes from a semisolid to a liquid state under the conditions of ASTM Method D-566. Greases do not have true melting points, but as they are heated there is a temperature at which they soften rapidly and a narrow range in which they liquefy.

Drum. Cylindrical steel container for petroleum products, most commonly 55-gallon size, in 16- or 18-gage steel.

Drum, Collapsible. A 500-gallon collapsible fabric drum. (All other sizes of liquid fuel collapsible containers are considered tanks, not drums.)

Drum Filler. An apparatus for filling drums automatically to a fixed volume or weight.

Drum Thief. A metal or plastic tube, 1 1/2 inches in diameter and 30 inches long, used to withdraw samples from drums.

Drycleaning Solvent. See Stoddard Solvent.

Dry Gas. A gas which does not contain fractions that may easily condense under normal atmospheric conditions.

Dry Point (dp). In a distillation test, the temperature at which the last drop of petroleum fluid evaporates.

Duplex Pump. See Pump, Duplex.

Dynamic Head. A measure of pressure in liquids in motion; a measure of potential energy or energy of position; the static head required to accelerate the stream to its flowing velocity; the elevation to which a pump can push a column of liquid.

Ebullition. 1. The boiling or bubbling of any liquid, caused by the formation of gaseous bubbles in its mass, due to the application of heat, to the escape of dissolved gas when pressure is released, or to chemical action. 2. A state of agitation resembling boiling produced by passing air or gas through a liquid.

Efficiency. See Mechanical Efficiency and Thermal Efficiency.

856

Effluent. Outflowing or outflow; a term applied to a stream that has passed through a process or apparatus and has been altered in some way; product flowing out of a filter/separator, for example, or past a device that adds an inhibitor.

Elbow. An ell-shaped pipe fitting, struck to a smaller radius than a bend, used to form an angle between adjacent pipes. The angles are 11 1/4°, 22 1/2°, 45°, and 90°.

Electrode. The positive or negative terminal of an electric circuit. The positive electrode is called the anode; the negative electrode, the cathode.

Electrolysis. Chemical decomposition by the action of an electric current. This process is both the cause of external corrosion of buried pipelines and the basis for providing protection against such corrosion.

Electromotive Series. A listing of metals and alloys arranged in such order that any metal in the list is anodic to (corroded by) any metal following it, and any metal in the list is cathodic to (protected by) any metal preceding it.

Emulsion. A suspension or dispersion of fine droplets of one liquid in another. An oil emulsion, a common form of emulsion, is oil suspended in water. A water emulsion is water suspended in oil. The lighter the product, the more rapidly emulsions break down; the heavier the product, the more persistent emulsions become. An emulsifier or emulsifying agent is a substance used to promote formation of stable emulsions. Emulsifying or emulsification is formation of emulsions; demulsifying or demulsification is breaking down emulsions. Emulsifying tendency of lubricating oils is determined by FTM No. 3201-5; that of soluble cutting oils by FTM No. 3205.1; and the resistance of uninhibited turbine oils to emulsifying (the steam emulsion number) is determined by ASTM D-1401.

Endothermic. Heat absorbing (cooling); an endothermic reaction is one in which heat is absorbed, as in the cooling effect of expanding gas (the principle of refrigeration) or in the evaporation of gasoline (resulting in carburetor icing).

End Point (ep). The point indicating the end of some operation or at which a certain definite change is observed. In titration, this change is frequently a change in color of an indicator which has been added to the solution, or the disapperance or excess of one of the reactants which is colored. In the distillation of liquids, such as gasoline, the end point is the maximum temperature which occurs during the test.

Engine Deposit. A general term applicable to any of the following: gum, sludge, carbon, acid, and all other combustion products which the engine produces from fuel and oil. It also covers the foreign substances which enter and accumulate throughout the inside of the engine.

Engine Oil. A term applied to oils used for the bearing lubrication of all types of engines, machines, and shafting, and for cylinder lubrication in other than steam engines.

Engler Distillation. A standard test for determining the volatility characteristics of a gasoline by measuring the percent distilled at various specified temperatures. This test is described in ASTM Method D-86.

English Melting Point. See Melting Point.

Entrained Water. See Water, Entrained.

Ethane. A gaseous paraffinic hydrocarbon, CH_3CH_3, occurring in natural gas.

Ethylene. A colorless olefinic gas, C_2H_4, with a characteristic sweet odor and taste; derived from the cracking of petroleum.

Ethylene Glycol. A colorless, odorless, sweet-tasting dihydric alcohol, CH_2OHCH_2OH, used as an antifreeze.

Evaporation. The conversion of a liquid into vapor, usually by means of heat.

Evaporation Loss. Evaporation loss is the loss of a liquid volume or weight due to the free evaporation of the liquid usually in a storage tank at atmospheric pressure. It varies with the temperature, the amount of liquid surface exposed, the temperature of vaporization of the lightest components of the liquid, the velocity of air currents over the surface exposed and the degree of vapor tightness of the tank roof. Since petroleum products are not homogeneous liquids the rate of evaporation is not constant, being greatest at the beginning when the largest percentage of light volatile hydrocarbons are present and slowest when evaporation has proceeded so far that only heavy residues are left.

Evaporation Test. The test applied to volatile petroleum products to determine the completeness or rapidity of evaporation.

Existent Gum Test. See Gum Test.

Exothermic. Relating to or designating a reaction which occurs with the evolution of heat, so that the temperature of the reacting bodies is raised; e.g., an exothermic reaction occurs when sulfuric acid is mixed with water.

Expansion Joint. A joint or coupling designed so as to permit an endwise movement of its parts to compensate for expansion or contraction.

Explosimeter. See Gas Detector.

Explosive Limits. The limits of percentage composition of mixtures of gases and air within which an explosion takes place when the mixture is ignited. The lower limit of flammability corresponds to the minimum amount of combustible gas and the upper limit to the maximum amount of combustible gas capable of conferring flammability on the mixture. (Also referred to as flammable limits and explosive range.)

Explosionproof Lights. See Lights.

Extreme-Pressure (EP) Lubricant. Any of the lubricating oils or greases which contain a substance or substances specifically introduced to prevent metal-to-metal contact in the operation of highly loaded gears. In some cases, this is accomplished by the substances reacting with the metal to form a protective film.

Fahrenheit Scale. A thermometer scale on which the freezing point of water is 32° and the boiling point is 212° (at sea-level atmospheric pressure).

Fatty Oil. Oily liquid consisting of a chemical combination of glycerin and fatty acid. Examples of fatty oils are cottonseed oil, lard oil, and castor oil. (See Saponification Number.)

Federal Test Method Number (FTM No.). This number refers to the standard test method described in Federal Test Method Standard No. 791 for testing petroleum products when there is no applicable ASTM test method available or standardized.

Feeder (Flood) Pumps. Pumps generally installed to supply the required suction pressure between tank farm installations and main line (trunk) pump stations, or to feed fuel through short branch lines to dispensing tankage installations.

Feet of Head. The measure of pressure in terms of the height in feet of a column of a given fuel. This measurement is convenient for use in hydraulic design of pipelines, since it can be applied directly to terrain elevations.

Figure-Eight Blank. A pipe blank, or blind, in the form of a figure eight. One circle of the eight is solid to form a blank, and the other circle is open. It is used in locations where a line must be periodically blanked off and a visible indication is required to show whether the line is blank or open.

Fill Stand. See Loading Rack.

Film Strength. The property of an oil which enables it to maintain an unbroken film on lubricated surfaces under operating conditions, where otherwise there would be scuffing or scoring of the surfaces.

Filter (noun). A porous material on which solid particles are caught and retained when a mixture of liquids and solids is passed through it.

Filter (verb). To mechnically remove solids or free water from a petroleum product.

Filter/Separator. A device used to separate both solid contaminants and water from a petroleum fuel.

Final Boiling Point (fbp). See End Point.

Fire Point. The lowest temperature at which, under specified conditions in standardized apparatus, a petroleum product vaporizes rapidly enough to form an air-vapor mixture above its surface which burns continuously when ignited by a small flame.

Firewall. See Dike.

Flame Arrester. An assembly of perforated plates or screens enclosed in a case and attached to the breather vent on a petroleum storage tank. The device prevents a flame from entering the tank through the vent.

Flame Propagation. The spread of the flame in a combustible body from the point at which combustion began.

Flammable. A term describing any combustible material which can be ignited easily and which will burn rapidly. Petroleum products which have flashpoints of 80° F. or lower are classed as flammable.

Flammable Limits. See Explosive Limits.

Flashpoint. The lowest temperature at which vapors arising from a petroleum product will ignite momentarily (i.e., flash) on application of a flame under specified conditions. Laboratory methods for determining flashpoint are ASTM Method D-56 (for all mobile liquids flashing below 175° F.), ASTM Method D-92 (for all products except fuel oils and those flashing below 175° F.), and ASTM Method D-93T (for fuel oils, viscous materials, and suspensions of solids). The Pensky-Martens closed tester is used to determine flashpoint and fire point of oils (ASTM D-93).

Floating-Roof Tank. A tank with a roof that floats on the surface of the liquid contents. The roof, which has a tight seal of synthetic rubber around its perimeter, rises and falls with the changes in product level. When the roof falls to a certain distance from the bottom, it comes to rest on supports. Because there is no vapor space between the surface of the product and the roof, breathing and filling losses are practically eliminated.

Flood Pump. See Feeder (Flood) Pumps.

Flow Point. The temperature at which asphalt or other mixtures of noncrystalline hydrocarbons begin to flow; a measure of fluidity.

Flying Cow (or Bladder Bird). A C-123 (now obsolete) or C-130 transport aircraft carrying petroleum to a forward unit or staging field in one or two 3,000-gallon collapsible tanks equipped with a 4-inch hose system. The flying cow can pump out 1,200 to 6,000 gallons of fuel in 6 to 15 minutes of ground time.

Flying Crane. A CH-54A helicopter.

Foaming. The formation of froth or foam on lubricating oils or other oils as a result of aeration or release of gas dissolved in the oil. Foaming characteristics of lubricating oils are determined by ASTM Method D-892.

Fog Oil. A petroleum oil used in smoke generators produced in accordance with Specification MIL-F-12070 in Type SFG-1 (for temperatures above 40 degrees F.) and Type SFG-2 (for temperatures of 40 degrees F. or lower).

Foot Valve. Special-purpose check valve. (See Priming.)

Fractional Distillation. The separation of the components of a liquid mixture by vaporizing and collecting the evaporated fractions, or cuts, which condense in different temperature ranges.

Free Water. See Water, Free.

Friction Loss. Loss of pressure, in terms of feet of head per unit of pipe length, from internal resistance to flow in the product itself (viscosity) and from resistance offered by pipe walls, pipe fittings, and reductions in pipe diameter.

Fuel-Air Ratio. See Air-Fuel Ratio.

Fuel Oil. Any liquid petroleum product burned for the generation of heat in a furnace or firebox, or for the generation of power in an engine, exclusive of oils with a flashpoint below 100° F. (Tag closed-cup tester) and oils burned in cotton- or wool-wick burners.

Fuel System Icing Inhibitor (FSII). An agent consisting of 97 percent ethylene glycol and 3 percent glycerol added to turbine fuels to prevent icing.

Fumes. See Suspension.

Furnace Oil. A distillate fuel intended primarily for use in domestic heating equipment.

Furol Viscosity. See Viscosity, Saybolt Furol.

Gage (noun). An object used as a standard of measurement or comparison, i.e., an instrument for measuring, indicating, or regulating the capacity, quantity, amount, or other properties of anything.

Gage (verb). To measure the contents or capacity, as of a tank. (See Innage, Outage.)

Gage Glass. A glass tube with one or more petcocks, called gage cocks, affixed to a boiler, still, tank, or other vessel to furnish a visual indication of the level of the liquid in the vessel.

Gage Pressure. The pressure as shown by a pressure-registering instrument (gage). The gage pressure, in pounds per square inch, is approximately equal to the absolute pressure minus 14.7.

Gage Sheet. One of the sheets prepared to show the contents of a storage tank for each 1/8 inch or 1/16 inch of product contained in the tank.

Gage Table. Tables prepared to show the contents of a tank for each 1/8 or 1/16 inch of oil contained in the tank. After the tank has been gaged with a steel tape or pole and the height of the liquid determined, the contents of the tank can be found by reference to these tables. The tables are compiled either through an ordinary calibration of the tank, or by a mathematical computation of the cylindrical volume for each inch of altitude, deducting the volume occupied by "deadwood." Tables of temperature corrections are often made available for use in reducing the measured contents of the tank to a standard volume at 60° F. These volume calculation and correction tables are identified in ASTM D-1250. These methods together with extensive supplementary information are issued in a separate publication entitled "ASTM Manual on Measurement and Sampling of Petroleum and Petroleum Products."

Gaging for Water. Obtaining the depth of water bottom by thiefing or taking water cut. This is normally accomplished by coating a plumb bob, tape, or gaging stick with water finding paste.

Gallon (gal.). A unit of measure of volume. A U.S. gallon contains 231 cubic inches or 3,785 liters; it is 0.83268 times the imperial gallon. One U.S. gallon of water weighs 8.3374 pounds at 60° F.

Gas. A form of matter. A fixed gas is a substance, natural or manufactured, which exists as a gas under ordinary conditions. The term is often used loosely to refer to a fume or vapor.

Gas Detector. An instrument for determining the explosibility of a gas-air mixture; explosimeter.

Gasoline. See Automotive Gasoline, Aviation Gasoline.

Gas Turbine. An engine in which vapor (other than steam) is directed, under pressure, against a series of turbine blades. The energy contained in the rapidly expanding vapors is converted into rotary motion.

Gear Pump. See Pump, Gear.

Go-Devil. See Scraper.

Graphic Method of Dispatching. A visual method of control in which movements of batches are plotted in terms of time on a vertical axis and pipeline distance in barrels on a horizontal axis. Batch positions are plotted every 1 or 2 hours, and the sloping lines made by connecting the points representing ends of batches show flow rates in the pipeline at the time of plotting. The projected rates of flow provide a means of estimating arrival times at downstream stations.

Gravitometer. Permanently installed hydrometer that gives a continuous reading of the API or specific gravity of the product passing through the pipeline. (See Hydrometer.)

Gravity. See API Gravity and Specific Gravity.

Grease. A mixture of petroleum oil, soap (or other thickeners), and sometimes an additive, used for lubricating under conditions where an oil cannot meet all requirements. (See specific greases under alphabetical listing.)

Groove-Type Coupling. A coupling consisting of two segments, bolts for fastening the segments together, and a self-sealing gasket. Each segment engages a groove around the end of each pipe, and the gasket fits over the ends of both pipes. When the bolts are tightened, the segments center and compress the gasket to form a tight joint.

Grooving Tool. A device used to cut grooves on the ends of plain pipe prior to the installation of grooved-type couplings.

Gross Tank Capacity. Tank capacity to maximum fill level; includes non-recoverable tank bottoms. Is synonymous with "storage capacity."

Grounding. Electrically connecting single or bonded units to a ground rod so that any static potential that might exist or that might be generated will be discharged into the earth. If two or more units are bonded and one is grounded, the whole system is effectively grounded. (See Bonding.)

Ground Products. Those refined petroleum products normally intended for use in administrative, combat and tactical vehicles, material handling equipment, special purpose vehicles and stationary power and heating equipment.

Gum. Varnish-like, tacky, noncombustible insoluble deposits formed during the deterioration of petroleum and its products, particularly gasoline. The amount of gummy material in gasoline is known as its gum content, which is determined by ASTM Methods D-381 and D-525. (See Gum Test.)

Gum Test. 1. An analytical method for determining the amount of existing gum in gasoline by evaporating a sample from a glass dish on an elevated-temperature bath with the aid of circulating air. 2. Any gum test carried out in accordance with an ASTM gum test procedure. (ASTM Method D-381 and ASTM Method D-525 are generally used in the United States for determining gum content in motor gasoline.)

Gunk. See Sludge.

Head. An expression of pressure, usually stated in terms of inches or feet. (See Dynamic Head; Static Pressure; Hydrostatic Pressure.)

Header. A common manifold in which a number of pipelines are united.

Heart Cut. 1. A narrow-range cut, usually taken near the middle portion of the stock being distilled or treated. 2. A delivery of pure product from the middle of a batch at some intermediate point on the pipeline.

Heavy Ends. The highest boiling portion of a petroleum fraction.

Heavy Product. When storing filled drums, a heavy product is a liquid which gives off flammable vapors above the temperature of 80° F.

Heptane. Normal heptane is a hydrocarbon (C_7H_{16}) of the parrafin series with an octane rating of zero. It is used in combination with iso-octane, a paraffin with an octane rating of 100, to determine octane ratings of test fuels.

Hercules. A C-130E Air Force transport aircraft sometimes used as a flying cow. (See Flying Cow.)

Highest Useful Compression Ratio (HUCR). The optimum value of the compression ratio; it varies with fuel, engine, and operating conditions.

Horsepower (Mechanical). Power is the rate of doing work. One mechanical horsepower equals 33,000 ft.-lbs. per minute or 550 ft.-lbs. per second.

Hot Refueling. Refueling a rotary-wing aircraft while its engines are running. (See Miniport.)

Hot Spot. An area in the combustion zone of an engine which remains at a higher temperature than the surrounding metal, which can aggravate detonation or preignition.

Hydraulic Fluid. A fluid of petroleum or nonpetroleum origin used in hydraulic systems. Low viscosity, low rate of change of viscosity with temperature, and low pour point are desirable characteristics.

Hydraulic Gradient. The progressive and continuous drop in pressure in a pipeline resulting from resistance to flow.

Hydraulic Gradient Triangle. A right triangle so constructed that the slope of its hypotenuse represents the rate of pressure loss due to friction of a given fluid flowing through the pipeline of a given size at a given initial pressure. Altitude of the triangle represents the initial pressure; base of the triangle represents the total length of pipe through which the fluid can be moved against friction alone by the initial pressure; when applied to the profile of the pipeline route drawn to the same scale, this triangle locates the point where pressure losses due to both friction and elevation require the location of another pump station.

Hydrocarbon. A compound containing only hydrogen and carbon. The simplest hydrocarbons are gases at ordinary temperatures; but with increasing molecular weight, they change to the liquid form and, finally, to the solid state. Hydrocarbons are the principal constituents of petroleum.

Hydrolysis. A chemical decomposition in which a compound is broken up and resolved into other compounds by reaction with water. In many cases, it is induced by the presence of a small amount of dilute acid or of an enzyme.

Hydrolytic Stability. Water tolerance of aviation fuels; the interaction of water and aircraft fuels (solubility of water in aviation fuels). (ASTM D-1094.)

Hydrometer. A graduated instrument for determining the gravity of liquids. It is usually made of hollow glass and weighted at one end so as to float upright. The depth to which the instrument sinks when immersed in a liquid is determined by the density of that liquid--the lighter the liquid, the lower the instrument sinks. Some hydrometers are marked to read percentage of constituent, or some other property related to gravity. Hydrometers used in measuring petroleum products usually read degrees API or specific gravity.

Hydrostatic Head. That portion of the indicated pressure at a point in a piping system or pipeline, which is due to the super-imposed height of the liquid head acting at that point.

Hydrostatic Pressure. Pressure within a static column of liquid due only to weight of the liquid; hydrostatics is that part of hydraulics that deals with liquids at rest; hydrokinetics deals with liquids in motion; hydrodynamics deals with the forces exerted upon liquids by objects in motion. (See Head.)

Icing. The solidification of particles of moisture in the fuel system, especially the carburetor, of an aircraft or ground vehicle. The moisture may either be contained in the fuel or enter the system through the air intake. Icing may cause either partial or complete loss of power.

Identification Tests. Selected tests applied to a sample to quickly identify the type or grade of material represented or to determine that the quality has not been altered by time or handling.

Ignition. See Compression Ignition.

Ignition Point. The point on a temperature scale at which a substance may be ignited to produce combustion.

Ignition Quality. The ability of a fuel to ignite upon injection into the engine cylinder.

Ignition Temperature. See Autogenous Ignition Temperature.

Ignition Quality of Diesel Fuel. See Cetane Number.

Illuminating Oil. A petroleum oil, heavier than gasoline, used for lighting purposes. (See Burning Oil.)

Impeller. A device which impels or pushes forward, such as the rotor of a centrifugal pump or air compressor.

Incremental Pressure. The difference between the suction and discharge pressure of a pump or of a multipump pump station.

Induction Period. The period of time a gasoline may be subjected to accelerated aging before a break in stability occurs.

Inhibitor. A substance added in small amounts to a petroleum product to prevent or retard undesirable chemical changes from taking place in the product, or in the condition of the equipment in which the product is used. In general the essential function of inhibitors is to prevent or retard oxidation or corrosion.

Initial Boiling Point (ibp). The temperature at which the first drop of liquid falls from the end of the condenser (ASTM Method D-86).

Initial Vapor Pressure (ivp). The vapor pressure of a liquid at a specified temperature and "zero precent evaporated." It may be determined either by measuring the vapor pressure in an apparatus with substantially zero vapor-to-liquid ratio or by extrapolating to zero vapor space the experimental vapor pressures obtained at several low ratios of vapor-to-liquid volume. The initial vapor pressure (ivp) of ordinary wide petroleum cuts is somewhat higher than the standard Reid vapor pressure (Rvp), up to approximately 50 pounds Rvp. With close-boiling cuts, the difference is less noticeable; and with pure components, there is no difference between ivp and Rvp.

Innage. The height or volume of liquid in a storage tank, as measured or gaged from the bottom of the tank to the top of the liquid.

Innage Tape and Bob. A steel measuring tape connected by a harness snap to the eye of a conical-tipped bob. Used to measure the distance from the bottom of the tank to the liquid level of product in a tank or gage pipe.

Insulating Oil. An oil used in circuit breakers, switches, transformers, and certain other electrical devices for insulating, cooling, or both. In general, such oils are well-refined petroleum distillates of low volatility and high resistance to oxidation and sludging.

Interface. A mixture, or commingling, between adjacent products in a multiproduct pipeline; interfacial mixture.

Internal-Combustion Engine. An engine which operates by means of combustion of a fuel within its cylinders.

Into-Plane. The requirement/procurement of fuel and lubricating oils for delivery into government-owned aircraft normally at non-military air facilities. Charges for this include the cost of fuel, lubricating oils and related services.

Inventory. Bulk tankage contents measured to current product level; includes tank bottoms and associated pipeline fill.

Iso-Octane. A colorless, paraffinic liquid, C_8H_{18}, with a boiling point of 210.5° F. and an arbitrary octane rating of 100. It is used for organic synthesis; in motor fuels; and with normal heptane (zero octane rating), to prepare standard mixtures for use in determining the octane ratings of test fuels.

Jet Engine. An engine which converts air and fuel into a fast-moving stream of hot gases which effect propulsion of the device of which the engine is a part.

Jet Fuel. Fuel meeting the required properties for use in jet engines and aircraft turbine engines. Jet fuels are procured for the Armed Forces in several grades, the most important of which are JP-4 (low vapor pressure) and JP-5 (high flashpoint), both produced under Specification MIL-T-5624 and designed for use in aircraft turbine engines; JP-6, produced under Specification MIL-J-25656 and designed for use in aircraft turbine and jet engines of land-based supersonic aircraft; and RJ-1, produced under Specification MIL-F-25558 and designed for use in ramjet aircraft engines. Jet fuel is usually called JP (jet propulsion) fuel.

Joint Petroleum Office (JPO). An office established by the Joint Chiefs of Staff to discharge staff petroleum logistics responsibilities in a Unified Command overseas.

Kerosene. A refined petroleum distillate used in space heating units, in wick-fed lamps, in bomb-type flares, for cleaning certain machinery and tools, and as a vehicle for liquid insecticide sprays. A single multiple-use type is procured under Federal Specification VV-K-211. A deodorized type, which is used as a vehicle for insecticide sprays, is procured under Specification VV-K-220.

Kinematic Viscosity. The ratio of the absolute viscosity to the density at the temperature of the viscosity measurement. The metric units of kinematic viscosity are the stoke and centistoke, which correspond to the poise and centipoise of absolute viscosity.

Kinetic Energy. Energy due to motion.

Knock. The noise associated with self-ignition of a portion of the air-fuel mixture ahead of the advancing flame front which is presupposed to be moving at normal velocity.

Knock Characteristics. Octane number (motor) of motor gasoline (ASTM D-357); Octane number (research) of motor gasoline (D-908) performance number (lean mixture) of aviation fuels (D-2700); and performance number (supercharge) of aviation fuels (D-909).

Lacquer. A coating, resembling natural varnish, left on parts of a gasoline engine as a result of the oxidation of gasoline and oil.

Laminar Flow. A smooth, streamline flow in which product in a pipeline is said to flow in concentric layers. When the velocity of flow increases beyond a certain point (critical velocity), the layers disintegrate and the flow becomes chaotic, or turbulent. (See Turbulent Flow.)

Lamp Burning Test. A test in which kerosene is burned in a standard lamp under specified conditions to observe the steadiness of the flame, the degree of incrustation of the wick, and the rate of consumption of the kerosene.

Lard Oil. An oil prepared from the fat of swine. It is compounded with mineral oils to produce lubricants of special properties, especially cutting oils.

Lead. A general term used to denote tetraethyllead or other organometallic lead antiknock compounds used as gasoline additives.

849

Lead Acetate Test. A test used to detect the presence of hydrogen sulfide in a sample.

Lead Gasoline. Gasoline containing an organometallic lead antiknock compound, such as tetraethyllead.

Lead Poisoning. Poisoning caused by tetraethyllead or another of the organometallic lead antiknock compounds used as additives in gasoline. It may result from ingestion, absorption through the skin, or inhalation of fumes.

Lead Susceptibility. The ability of gasoline to respond to the addition of an organometallic lead antiknock compound, such as tetraethyllead. This characteristic is measured in terms of increase of antiknock quality per increment of lead.

Light Ends. The most volatile portions of a carbohydrogen mixture, the low boiling components that boil off first in distillation; opposed to heavy ends.

Light Product. For storage of filled drums, a light product is any liquid which gives off flammable vapors at or below 80° F.

Lights. Only "explosionproof" lights, motors, switches, or other electrical fixtures approved by the Underwriters Laboratories for class 1, group D hazardous locations are to be employed where concentrations of flammable gases or vapors exist continuously, intermittently, or periodically under normal conditions. Hazardous locations classified as class 1, group D are: atmosphere containing jet fuel JP-4, gasoline, petroleum naphtha, alcohols, acetone, lacquer solvent vapors, and natural gas.

Liquefied Petroleum Gas (LPG). Light hydrocarbon material which exists as a gas under normal conditions but which has been converted to a liquid state by pressure. Commercial liquefied gas consists of propane, butane, or a mixture of the two.

Liter (l.). A metric unit of capacity equal to 0.9081 dry quart (U.S.) or 1.0567 liquid quarts (U.S.).

Load-Carrying Ability (Capacity). See Film Strength.

Loading Rack. A structure with one or more risers, loading valves, arms, and drop tubes, built alongside railroad tracks for the purpose of loading railroad tank cars; also, a structure built in a tank-vehicle loading area for the purpose of transferring product into tank trucks; fill stand; loading stand.

Looped Line. 1. A doubled pipeline constructed for the purpose of increasing capacity or reducing pressure losses. 2. An alternate section of pipeline built around a break or a point of potential damage, such as at a river crossing, to restore or maintain operations during repairs.

Lower Sample. A sample taken with a bottle or beaker sampler from the middle of the bottom third of a tank's contents.

Lubricant. A substance, especially oil, grease, and graphite, which may be interposed between moving surfaces to reduce friction and wear.

Lubricating Film. The thin film of lubricant between two solid surfaces which acts to keep the surfaces from making contact with each other. The adhesiveness and cohesiveness of the lubricant account largely for establishing and maintaining this film.

Lubricating Grease. A solid or semifluid material consisting of a thickening agent dispersed in a liquid lubricant. Other ingredients, such as additives and fillers, may be included to impart special properties.

Lubricating Oil. A fluid lubricant used to reduce friction between bearing surfaces. Petroleum lubricating oils are produced from distillates or from residues. To impart or improve certain properties, additives are frequently blended with lubricating oils.

Manhole (Manhead). An access opening in a tank or other structure to allow entry of a man for inspection, cleaning, or repair.

Manifold. A piping arrangement which permits a stream of liquid or gas to be divided into two or more streams, or which permits several streams to be collected into one. See Header.

Manometer. An instrument used to measure pressure of vacuum.

Mass. Quantity of matter; mass remains constant, but the weight of a mass varies with the pull of gravity; specific gravity is the ratio between the weight of a quantity or mass of a substance and the weight of an equal quantity of water. Weight equals mass times the pull of gravity.

Maximum Fill Level. The point above which container must not be filled.

Maximum Head Capacity. The total head against which a pumping unit will pump to provide maximum pipeline capacity. Maximum head capacities are for emergency operation only and are never used as the basis for design.

Mechanical Efficiency. The indication of the power required to run an engine. It is equal to the power available at the flywheel divided by the actual power developed by the engine cylinders.

Melting Point (m.p.). The temperature at which a solid substance melts or fuses. The melting points of asphalts, waxes, and paraffins are determined by several methods; especially ASTM Method D-87 (for paraffin wax) and ASTM Method D-127 (for petroleum and microcrystalline wax). ASTM melting point. The temperature at which wax first shows a minimum rate of temperature change; also known as the English melting point.

Meniscus. The curved surface of the top of a column of liquid in a narrow tube; the curve is concave when the containing walls are wetted with the liquid and convex when not wetted.

Mercaptans. Sulfur compounds, analogous to alcohols, in which the sulfur has replaced oxygen; the simplest forms have repulsive, garlic-like odors, which become less pronounced with increased molecular weight and higher boiling points; mercaptides are compounds of metals with mercaptans; lead mercaptides are formed in the sweetening process (ASTM D-1219).

Methane. A light, odorless, flammable gas, CH_4; the first member of the paraffin series (which see). It is the principal constituent of natural gas.

Methylethyl Ketone (MEK). A volatile organic liquid, soluble in water; a component of the solvent used in dewaxing lubricating oils and thinner for nitrile rubber cements.

Micron (μ). One micron is a thousandth part of one millimeter (approximately 25,400 microns equal 1 inch). The average human hair is about 100 microns in diameter.

Middle Sample. A sample taken from the middle of a tank's contents.

Mike. A term used to denote measurement of bulk petroleum products in thousands of gallons or barrels, i.e., 10 mike barrels = 10,000 barrels.

Mineral Oil. A wide range of products derived from mineral substances.

Miniport. A refueling point for "hot refueling" of rotary-wing aircraft. (See Hot Refueling.)

Mixed Aniline Point. The lowest temperature at which a solution of 2 parts aniline, 1 part hydrocarbon sample, and 1 part n-heptane, heated until miscible, begins to separate into 2 phases (aniline and sample plus heptane). Mixed aniline point is determined by ASTM Method D-611. (See Aniline Point.)

Mixed Sample. A sample taken by mixing or stirring the original sample and then drawing off the desired quantity for testing.

Mixture. The intermingling of two or more substances in which each retains its original properties.

Molecular Weight. The sum of the atomic weights of the atoms composing a molecule.

Molecule. Unit of matter; the smallest particle of an element or compound that retains chemical identity with the substance in mass.

Motor Fuel. See Automotive Gasoline, Aviation Gasoline, and Jet Fuel.

Motor Method. A test for determining the knock rating, in terms of ASTM motor octane numbers, of fuels for use in spark-ignition engines. The knocking tendency of the fuel under test is compared with knocking tendencies of reference fuels of known octane number (ASTM Method D-357).

Multigrade Oil. A multiviscosity number oil which combines three SAE viscosity number grades. At present, multigrade oils are not carried in Army supply channels.

Multipurpose Grease. A lubricating grease suitable for use as a chassis lubricant, a bearing lubricant, a joint lubricant, a water pump lubricant, and as a cup grease, such as Grease, automotive and artillery (Specification MIL-G-10924).

Multistage Pump. See Pump, Multistage.

Napalm. A thickened gasoline used as an incendiary medium. It tends to adhere to the surface it strikes.

Naphtha. A general term applied to refined, partly refined, and unrefined petroleum products and liquid products deriving from natural gas which distill chiefly between 347 degrees F. and 460 degrees F.

Naphthene. One of a group of cyclic hydrocarbons with the general formula C_nH_{2n}. Naphthenes are also termed cycloparaffins or cycloalkanes.

Naphthenic Crude. Crude oil with a relatively high percentage of naphthenes.

Natural Gas. Naturally occurring mixtures of hydrocarbon gases and vapors, the more important of which are methane, ethane, propane, butane, pentane, and hexane.

Natural Gasoline. A mixture of liquid hydrocarbons extracted from natural gas by various methods and stabilized to obtain a liquid product suitable for blending with refinery gasoline.

Neoprene. A synthetic rubber used in the manufacture of such products as adhesives, paints, and tank linings. It is superior to natural rubber in a number of ways, especially in its resistance to deterioration when subjected to petroleum products.

n-Heptane. See Heptane.

Nitrile Rubber. A type of synthetic rubber made by the copolymerization of butadiene and acrylonitrile. It is especially resistant to the swelling action in oils, solvents, and greases, and is used in gasoline and oil hose and for tank linings. Originally called Buna N, it is also known as N-BR (nitrile-butadiene rubber).

Non-Recoverable Tank Bottom. That quantity of liquid that is below the suction manifold or drawoff line of a storage tank and is not available in normal day-to-day operations.

Nonsoap Grease. A grease which contains no soap thickeners.

Norma-Hoffmann Bomb Test. A test for determining the storage stability of lubricating greases. It is also known as ASTM Method D-942 (oxidation stability of lubricating greases).

Normal Combustion. A more or less orderly movement of the flame front across the combustion chamber. The knocking process shows similar flame progress for part of the way but terminates with the sudden ignition of the remainder of the unburned portion of the air-fuel mixture.

Normal Head Capacity. The total head against which a pumping unit will pump at the most efficient operating point.

Normal Pressure. Mean atmospheric pressure at sea level; taken to be equal to that of a column of mercury 760 millimeters high; about 14.7 pounds per square inch. (See Atmospheric Pressure).

Normal Solution. A solution containing one gram equivalent weight of the solute per liter of solution.

Normal Temperature. Room temperature; the prevailing existing temperature in the room where the test is run.

Ocean Terminal. An installation capable of discharging and loading ocean-going tankers.

Octane Number. Term used to indicate numerically the relative antiknock value of automotive gasolines and of aviation gasolines having a rating below 100. It is based on a comparison with the reference fuels, iso-octane (100 octane number) and normal heptane (0 octane number). The octane number of an unknown fuel is the volume percent of iso-octane in a blend with normal heptane which matches the unknown fuel in knocking tendencies under a specified set of conditions. Above 100, the octane number of a fuel is based on the engine rating, defined in terms of milliliters of tetraethyllead in iso-octane, which matches that of the unknown fuel.

Off-Specification Product. A product which fails to meet one or more of the physical, chemical or performance requirements of the specification.

Oil. Any one of three principal classes of combustible liquids of a wide gravity range. 1. Mineral oil consisting of hydrocarbons and derived from petroleum, coal, and shale. 2. Fixed or fatty oil consisting of glycerides and esters of fatty acids and derived from animal, vegetable, and mineral sources. 3. Essential oil consisting chiefly of hydrocarbons, having a characteristic odor or perfume, and being a concentrated extract of a certain plant.

Oil Emulsion. A suspension of minute droplets of oil in water; contrasted with a water emulsion which is a suspension of water droplets in oil.

Oiliness. A quality of lubricant that enables it to reduce friction between rubbing surfaces under given working conditions better than similar oil of the same viscosity and applied in the same way.

Olefin. One of a major series of hydrocarbons that appear chiefly in refinery operations; the substances have the general formula of naphthenes and the chain structures of paraffins, but differ from both in being unsaturated; molecular structure and nomenclature correspond to paraffins having the same amount of carbon; ethylene, or ethene, is the lowest member of the olefins and the series is sometimes called the ethylene series for this reason.

Opalescence. Milkiness or cloudiness; a term applied to an oil that contains visible wax.

Open-Cup Tester. An instrument used to determine flashpoint. (See Flashpoint.)

Opening Gage. An opening gage is a gage of a product taken immediately before delivery or receipt of product.

Outage. The volume of unoccupied space in a storage tank or other container, measured or gaged from a reference point above the product to the surface of the product; the difference between rated capacity and actual contents; some space will always be left unoccupied for expansion of product. (See Ullage.)

Outage Tape and Bob. A steel measuring tape connected by a harness snap to the eye of the rectangular-shaped bob. The outage tape and bob is used to measure the distance from a reference point above the product to the surface of the product in the tank.

Outlet Sample. A sample taken at the drawoff level of a tank.

Over or Short. A term used by the chief dispatcher in the daily accounting for product pumped into the line, product delivered from the line, and product remaining in the line; the difference between product put in the line and product taken from the line, plus or minus; may be explained by leaks and spills, evaporation, temperature differences not fully considered, slack line pressures, and errors in operations and postings.

Oxidation. 1. The process of combining with oxygen, a process which all hydrocarbons are capable of doing. 2. Oxidation characteristics of crankcase lubricating oils include their resistance to oxidation, their bearing corrosion characteristics, and the deposit of contaminants that result from oxidation and other changes as determined by FTM 3402. Oxidation stability of aviation fuels refers to the amount of gum and lead precipitate formed as a result of accelerated oxidation (potential gum), determined by ASTM D-873. Oxidation stability of lubricating greases refers to resistance of greases to change under static conditions for long periods; for example, when applied to antifriction bearings or motor parts, as determined by ASTM D-942.

Packaged Petroleum Fuels. Those fuels that are stored, transported, or issued in containers having a capacity of 55 gallons or less and in 500-gallon collapsible containers.

Packaged Petroleum Products. Those petroleum products other than fuels (generally lubricants, greases and specialty items) that are stored, transported and issued in containers having a capacity of 55 gallons or less. (See Bulk Petroleum Products.)

Packed Line. A petroleum pipeline filled with product under pressure from the pump station against a closed line valve.

Packing. A general term for a yielding material used to make a tight joint or connection; may be sheet rubber, asbestos, cork, or metal for gaskets, or braided and graphited hemp or asbestos material in strips or rings for stuffing boxes.

Paraffin. Any of the white, tasteless, odorless, and chemically inert waxy substances composed of saturated hydrocarbons obtained from petroleum.

Parallel Connection. Pumps are said to be connected "in parallel" when they receive product directly from the line and simultaneously; contrasted with connected "in series," in which the product goes through first one unit and then the other. Pumps in parallel deliver the cumulative volume of all pumps at the pressure of one pump; pumps in series deliver the volume of one pump at the cumulative pressure of all pumps.

Pascal's Law. A theorem that pressure applied to the surface of a confined liquid is transmitted equally and undiminished in all directions and acts at right angles to the confining surfaces.

Patrolling. Routine surveillance of the pipeline to detect actual or potential leaks and breaks and to discourage pilferage and sabotage. Patrollers may travel on foot or ride in motor transport or aircraft.

Peening. Hammering metals with the peen or rounded end of a hammer head to straighten them or to bend them into a curve. Leaks in the joints of tank plates can sometimes be stopped by peening the edge of the outside plate.

Penetrating Oil. A thin, nonviscous oil used to loosen rusted or frozen metal parts such as nuts, screws, bolts, or pins; not intended for use as lubricant; produced to Specification VV-P-216.

Penetration. A measure of the consistency of greases, petrolatums, asphalts, or other plastic products. Penetration number indicates the depth in 10ths of millimeters to which a pointed cone penetrates the sample when dropped from a given height (ASTM D-217).

Penetrometer. The device used to determine consistency of greases by penetration (ASTM D-217).

Pensky-Martens Closed-Cup Tester. See Flashpoint.

Performance Number (PN). An indication of relative engine performance, the relative knock-free power or output a supercharged aircraft engine can develop. Avgrade 115/145, for example, indicates a rating of 115 at lean mixture and a rating of 145 at rich mixture. The rating of 145 indicates that the engine can develop 145 percent as much knock-free power with the fuel at rich mixture as it could under the same conditions with a fuel having a performance number of 100.

Petrochemical. A contraction of the works "petroleum" and "chemical," originally coined to designate chemicals of petroleum origin. At present, it is so loosely used and covers such a wide variety of products that it cannot be defined specifically.

Petrol. A British term for petroleum; gasoline.

Petrolatum. A purified mixture of liquid or semisolid hydrocarbons. Jelly-like petrolatum is used as a basis for ointments and as a lubricant of limited application.

Petroleum. Crude oil. A mixture of gaseous, liquid, and semi-solid hydrocarbons varying widely in gravity and complexity, capable of being removed as a liquid from underground reservoirs of accumulation, and capable of being separated into various fractions by distillation and recovery. Petroleum burner fuels include those fuels burned under boilers or in furnaces for power or heat. Petroleum distillates include the groups of hydrocarbons yielded by distillation, or gasolines, napthas, kerosenes, gas oils, fuel oils, and lubricating oils. Petroleum gases include butane, propane, natural gas, and manufactured gas. Petroleum lubricants include lubricating oils and greases. Petroleum products is a general term that includes all petroleum fuels, lubricants, and specialties.

Petroleum Measurement Tables. ASTM-IP tables provided for the calculation of quantities of petroleum and its products under the required conditions in any of three systems of measurements; tables are provided for the reduction of gravity and volume to standard states over normal operating ranges, for calculation of weight-volume relationship, and inter-conversion of a wide variety of commercially useful units (ASTM D-1250).

Petroleum Oil, and Lubricants. See POL.

Petroleum Testing Kit. A kit (FSN 6640-310-8564) provided for limited quality surveillance testing under field conditions.

Phase. A uniform, physically distinct, and separable part of a mixture containing two or more unlike parts. An example of a three-phase mixture is ice, water, and water vapor. An example of a two-phase mixture is oil suspended in water or water suspended in oil in the form of an emulsion.

Phenolphthalein. A substance, sensitive to acids and alkalies, used as an indicator in chemical analysis in the laboratory. The substance remains colorless in an acid solution, but turns red when the solution becomes alkaline.

pH Value. The degree of acidity or alkalinity of a solution on a scale of 0 to 14; pure water and neutral solutions have a pH value of 7; acid solutions have values less than 7; alkaline solutions have values greater than 7.

Pickling. Acid treatment of plates and tubing used to loosen and remove mill scale, a product of oxidation and the steel rolling process. Mill scale is often a source of product contamination in new storage tanks and pipelines.

Pilot Valve. A relay valve that operates in connection with and controls another valve or valves.

Pinchcock. A clamp-like device used to control flow in a rubber tube by pinching the tube.

Pinging. Detonation or knocking. Pinging is another term for the too rapid combustion of the air-vapor mixture in an internal combustion engine.

Pipe Cutting and Beveling Machine. Used for military pipeline construction. Two types are provided, the hinged-ring and the horseshoe, and either will hold and guide a straight type oxyacetylene cutting torch around the pipe.

Pipehead. The downstream end of the pipeline with facilities for the storage, distribution, or forwarding of petroleum products.

Pipeline. A line of pipe with pump stations, storage tanks, and accessory equipment, for the movement of petroleum products.

Pipeline Batch. The quantity of product pumped into the pipeline in one continuous operation.

Pipeline Fill. The volume (quantity) of product required to completely fill a pipeline, whether in operation or not.

Pipeline Tender. A quantity of product offered or designated for pipeline shipment. It may be moved in one or more batches.

Pipe Plug. A threaded pipe fitting designed to close an opening in a pipe or in another pipe fitting.

Pipette. A graduated glass tube used for measuring small quantities of liquids in laboratory work.

Pipe Wrapping. The process of cleaning, treating, and wrapping the pipeline with a protective coating of treated tape before burying as a means of preventing corrosion.

Pitot Tube. A right angle tube used to measure velocity of a flowing stream. The horizontal leg, open to receive the force of the fluid, is immersed in the stream, and the rise of fluid in the vertical leg measures the velocity of flow.

Plasticizer. A substance added to a plastic or rubber material to maintain elasticity.

Plug Valve. A valve in which the line closing part is a revolving plug with an opening to permit passage of liquid when the opening is in alinement with the bore of the pipe. These valves are characterized by their rapid opening and closing capability, usually by turning a quarter turn with a removable handle, though some models have a control wheel with a worm gear. Most models do not permit passage of scrapers. Sealing action of plug valves is dependent on the pressure lubricating system of channels, as is the reduction of friction between the valve seat and the plug.

Plumbite Solution. (Doctor solution.) A mixture of sodium hydroxide (ACS) and lead oxide used in the test for detecting presence of mercaptan sulfur in gasoline, naphthas, and kerosenes.

Poise. Unit of absolute viscosity, or equal to 1 dyne-second per square centimeter. (See Centipoise and Viscosity, Absolute.)

POL. Petroleum, Oil, and Lubricants. Included within the meaning of this term are petroleum, fuels, lubricants, hydraulic and insulating oils, temporary protectives, liquid coolants, deicing and antifreeze compounds, together with components and additives of such products.

Polymerization. Changing a substance of a given molecular weight to another substance with chemical ingredients in the same proportions as in the first, but with a new molecular weight that is a multiple of the first, depending upon how many molecules of the first have been combined. It is a method of changing hydrocarbon gases into high octane gasoline.

Port. A term for either a suction or discharge opening of petroleum handling equipment or accessories.

Positive Displacement Pump. A pump that lifts or transfers fluid by positive or direct displacement without any transformation of energy. This pump differs from the centrifugal pump in which the rotating impeller first creates kinetic energy in the moving fluid and then transforms it into the potential energy of pressure in the fluid.

Post-Discharge Tests. Tests prescribed by MIL-HDBK-200 after receipt of a product as being most likely to indicate any contamination that might have occurred in transit.

Potential Gum. See Oxidation.

Pour Depressor. A lubricating oil additive which lowers the pour point of an oil containing wax by reducing the tendency of the wax to form a solid mass in the oil. Also called pour-point depressor; pour depressant.

Pour Point. The lowest temperature at which an oil can be poured. (ASTM D-97.)

Pour Stability Test. A method of estimating pour characteristics of winter grade motor oils in the field (FTM No. 203). Pour instability (pour reversion) is the difference between the ASTM pour point and the relatively high solidification temperature observed in the field.

Pour Test. The chilling of a liquid under specified conditions to determine the pour point. Observations are generally made over 5° F. intervals of temperature.

Power Pump. See Pump, Power.

Precipitation Number. The number of milliliters of precipitate formed when 10 milliliters of lubricating oil are mixed with 90 milliliters of a specified solvent and centrifuged under prescribed conditions (ASTM D-91).

Pre-Ignition. Premature ignition of the air-fuel mixture in a spark-ignition engine by some means other than the spark. Pre-ignition is often caused by overheated plugs or valves or by carbon deposits glowing with heat.

Preissue Tests. Tests prescribed by MIL-HDBK-200 before issue or reshipment of products to insure that satisfactory quality has been maintained.

Premium Grade. Refers to automotive gasoline, Specification VV-G-76, for use in motor vehicles and other engines where the manufacturer specifically designates use of a fuel of higher octane rating than regular grade gasoline.

863

Preservative. A petroleum product designed to prevent corrosion of ferrous and nonferrous metals. General purpose lubricating oils produced to Specifications VV-L-800, MIL-L-7870, and MIL-L-3150 have preservative qualities. See Federal Supply Manual C9100-IL.

Pressure. A force or impulse. Pressure differential is incremental pressure, or the difference between suction and discharge pressure of a pump. Pressure gage is an instrument used to measure and indicate pressure in a fluid. Pressure head is the pressure produced by a pump or by the weight of a column of liquid. Pressure lock is a device for gaging a pressure vessel. It consists of a gaging tape and bob housed in a vaportight assembly with a shutoff valve and mounted on top of the tank. Pressure reducing valve is a diaphragm-operated spring-loaded pressure regulator used on long downgrade slopes to prevent the buildup of excessive hydrostatic pressures when the line is shut down. Pressure vessel is an enclosed tank or other container in which a pressure greater than atmospheric is maintained. Pressure viscosimeter is the apparatus developed by Esso Research and Engineering for testing greases at elevated temperatures and pressures. Pressure viscosity is the increase in viscosity due to pressure observed in lubricating oils.

Pressure Drop. The decrease of pressure in pounds per square inch, or head in feet, of a fluid flowing in a piping system from one point to another point downstream from the first point. Pressure drop may be caused by friction, increase of elevation, or increase of velocity.

Priming. Displacement of air on the suction side of a centrifugal pump between the source of supply and the point of intake in the pump. Priming can be done by filling the pump casing with product to be pumped or by removing the air with a vacuum pump. A foot valve or check valve can be installed on the suction line to hold product when pumping stops.

Procurement Quality Assurance. That program by which the Government determines if a contractor has fulfilled his contract obligations pertaining to quality and quantity of products and related services.

886

Profile. A vertical section through the route of a pipeline, or other surveyed line on the earth's surface, showing distances out from a starting point and elevations above or below a datum plane. A profile is used with the hydraulic gradient triangle in modular design of the pipeline.

Propane. A gaseous hydrocarbon (C_3H_8), used for the same purpose as butane.

Prover Tank. A volumetric tank used to prove or calibrate a flow meter. It may be of the open type for measuring a delivery to another container when the test should be performed under actual operating conditions, or of the closed type when control of vapor losses is important. The tank may have a narrow neck with gage glass at top and bottom for added accuracy of measurements.

Pump. An apparatus for lifting or transferring fluids. The following are principal types of pumps:

Pump, Centrifugal (Volute Type). Consists of one or more impellers mounted on a rapidly rotating shaft. The liquid enters the impeller at the center, or "eye," and is impelled outward from the center by centrifugal force at high velocity into the volute of the pump casing. The function of the volute is to catch the impeller discharge and convert peripheral (tangential) velocity head into pressure head while conducting the liquid at a reducing rate of flow to the discharge nozzle of the pump casing.

Pump, Duplex. A reciprocating pump which has two liquid cylinders. Duplex pumps have a more steady discharge flow and pressure than do simplex pumps.

Pump, Gear. A positive-displacement pump of the rotary type that moves liquid by means of meshing gears rotating in opposite directions. Liquid enters on the suction side under atmospheric pressure and is carried to the discharge side in the spaces between the gear teeth and the wall of the pump chamber.

Pump, Multistage. A centrifugal pump which has two or more impellers mounted on the same shaft. The discharge from one impeller is conducted to the suction eye of the next impeller, etc. Petroleum products pumps with up to 14 stages and developing over 3,000 p.s.i. discharge pressure are in use.

Pump, Power. A reciprocating pump in which the liquid pistons are driven by other means than rods connected to direct acting steam pistons, usually by a crankshaft driven through gears or speed reducer by an automotive engine or electric motor.

Pump, Reciprocating. Consists of one or more cylinders into which liquid is sucked on the intake stroke of a piston, and discharged on the discharge stroke. It is usually driven by a direct-connected steam piston, although installations employing belt, gear, or chain drive by steam turbine, diesel engine, or electric motor may be used. It may commonly be of simplex, duplex, or triplex (1-, 2-, or 3-pump cylinders) and be single acting (1 working stroke per revolution utilizing 1 side of piston) or double-acting (2 working strokes per revolution utilizing both sides of piston). This pump is essentially a low-speed, low-capacity pump, and is best suited to the handling of small quantities of viscous liquids at high heads and variable discharge pressures.

Pump, Rotary. A positive-displacement pump used mainly to pump liquids that are either too viscous (or too volatile) to readily pick up from a lower level with a centrifugal pump. There are many types of rotary pump designs, the most common being the gear-type and lobe-type, in which two gears or lobes mesh and therefore rotate in opposite directions, with very close clearances between the rubbing surfaces and closely fitting the casing. The liquid is trapped between the gear teeth or lobes and the casing, and is carried around to the discharge side of the pump. The close meshing and minimum clearances prevent the liquid from bypassing to the suction side.

Pump, Simplex. A reciprocating pump that has one liquid cylinder on a direct rod drive, or driven by a single crank or rocker arm.

Pump, Single Acting. A reciprocating pump that discharges when the piston is moving in one direction only; contrasted with a double acting pump in which liquid continuously enters and leaves the cylinder from one end or the other.

Pump Booster. When the pressure of fluid flowing in a pipe is nearly expended and approaches zero, a booster pump is used to impart additional energy to the fluid. The energy thus imparted can be used to increase flow rate.

Pump Station. See Booster Station.

Pup Joints. Short pieces of pipe or nipples with grooved ends, which are shorter than standard lengths of pipe, used to close gaps in the line.

Purity. See Degree of Purity.

Qualified Products List. A list prepared by the procuring service of civilian type or off-the-shelf items that comply with appropriate specifications and have been found to be acceptable to the Government.

Qualitative Test. A determination of the nature of a compound or substance or the identity of its ingredients.

Quality Surveillance. The aggregate of measures taken to insure that petroleum products accepted by the Government as being of the required quality, are still of the required quality when delivered to the user. Quality surveillance includes watching over and caring for products during all storage and handling operations, adherence to handling methods and procedures designed to protect quality, and examination and testing of products in storage and on change of custody.

Quantitative Test. A determination of the amount of one or more constituents present in a compound or substance.

Quarter Bend. A 90-degree elbow connecting two lines of pipe at right angles to each other.

Quenching Oil. A mineral, fish, or animal oil used to cool and harden hot steel. The process is called tempering.

Rack. See Loading Rack.

Rapeseed Oil. A fixed lubricating oil pressed from rapeseed. It is used alone or in mineral oils to make compounded oils of high quality.

867

Rapid-Curing Cutback. Asphalt thinned with gasoline for easy handling in road work. Rapid evaporation of the solvent leads to early hardening.

Rate of Shear. The rate at which a series of adjacent layers of grease move over each other. A term used in the determination of apparent viscosity. It is defined as the shear stress (pressure in the lubrication system) divided by the rate of shear (ASTM D-1092).

Reaction. Chemical change that takes place when two or more substances are brought together. Reaction is accompanied by exchange of molecules and formation of other substances.

Reagent. A chemical substance capable of causing a reaction with another substance. Each reagent used has a known effect on certain elements and compounds. Qualitative and quantitative tests are performed on unknowns by observing the effects produced by various reagents on them. When a particular effect has been produced by a particular reagent, an effective identification of the unknown has been made.

Receiving Tests. Tests prescribed by MIL-HDBK-200B as being the means of rapidly supplying enough information on the quality of products received to plan their disposition.

Reciprocating. Moving alternately back and forth. A reciprocating engine or pump (positive displacement) is one in which pistons move back and forth in cylinders; reciprocation is converted to rotary motion, or vice versa, by connecting pistons to cranks.

Reciprocating Pump. See Pump, Reciprocating.

Reclamation. Restoring or changing a contaminated or off specification petroleum product so that it will either meet specifications completely or will be within use limits. (See Blending.)

Reducer. A coupling of a larger size on one end than on the other. It is used to connect pipe or pipe and other fittings of different diameters.

Reducing. Making smaller or lessening in any way. Reducing elbow is a pipe fitting used as a reducer on a turn or bend. Reducing tee is a pipe fitting having two sizes of openings, reducing on the run or on the branch or side outlet. Reducing valve is a valve that provides a constant lower pressure in the line beyond the valve.

Redwood Viscosity. British viscosity standard. Redwood viscosity indicates the time in seconds for 50 milliliters of sample to flow out of a Redwood viscosimeter at a definite temperature.

Reference Depth. In tank gaging, the reference depth (gaging height) is the distance from the reference point to the bottom of the tank.

Reid Vapor Pressure (Rvp). The measure of pressure exerted by a product on the interior of a special container under specified test conditions due to its tendency to vaporize.

Repeatability. The quantitative expression of the random error associated with a single operator in a given laboratory obtaining successive results with the same apparatus under constant operating conditions on identical test material.

Reproducibility. The quantitative expression of the random error associated with operators working in different laboratories, each obtaining single results on identical test material when applying the same method.

Requirements Balance. A computed difference between the quantity slated for tanker delivery during a month and the actual quantity received from tankers (DFSC cargo number) during that month.

Requiring Installation. A military installation, organization or activity authorized to requisition and receive material from designated distribution and storage points.

Responsible Officer. An individual, either civilian or military, responsible for the proper custody, care, and safekeeping of property entrusted to his possession or under his supervision to include pecuniary liability for any loss which might occur because of failure to exercise this obligation. (See also Accountable Officer.)

Reynolds Number (Re). A dimensionless value equal to velocity in feet per second times diameter in feet times kinematic viscosity in square feet per second. (See Critical Velocity.)

869

Rheology. The science of flow of viscous liquids.

Rich Mixture. An air-vapor mixture with insufficient air for good combustion.

Ring. In a storage tank, the circular arrangement of staves to form the tank wall. Bolted military storage tanks have from one to three rings.

Ring Structure. Refers to molecular structure of hydrocarbons of the naphthene and aromatic families.

Riser. A vertical supply or return line for steam, water, oil or gas; commonly found on loading racks.

Rising Stem. Refers to one type of gate valve in which only the valve stem and disk rise together when the valve is opened. This contrasts with the nonrising stem valve on which the handwheel, valve stem, and disk rise together when the valve is opened.

Riveted Construction. Refers to metal storage tanks with plates or sheets fastened together with rivets.

Road Oil. A nonhardening petroleum distillate or residual oil used to lay dust. It is usually applied without heating.

Rotary Pump. See Pump, Rotary and Pump, Gear.

Rotary Valve. A pilot or control valve used to actuate diaphragm operated valves. Such a valve may be used on a filter/separator to control the flow of fuel and to stop the flow of product in the presence of excessive water in the fuel.

Rust. Ferrous oxide. The product resulting from the oxidation of iron or steel in water or moist air.

Rust Preventive. A preservative oil used to provide a waterproof film over iron or steel surfaces exposed to oxidation.

SAE Numbers of Lubricants. A classification of lubricating oils for crankcases and transmissions in terms of viscosity only, standardized by the Society of Automotive Engineers (SAE).

Safe Refueling Rate. Maximum rates for refueling the different types of wheeled and tracked vehicles for greatest safety. These rates are listed in TB 746-93-1.

Safety Equipment Set. A standard item provided for the safe cleaning of storage tanks, tank cars and trucks, and tank trailers. The set contains fresh air respirators, centrifugal air blower, rubber boots and gloves, and an explosimeter or gas detector.

Safety Valve. Relief valve. An automatic valve used to release pressure above a given setting. The valve is a means of insuring that safe pressures are not exceeded.

Sample. A quantity of product taken as prescribed in ASTM D-270 for examination and testing. See specific kind of sample.

Sampler. A device used to obtain samples of various petroleum products. Other terms for sampler are thief or cheater. (See Bacon Bomb.)

Sandtrap. An arrangement of piping between the incoming scraper station and the suction side of the first pump, intended to collect floating debris, dirt, scale, or sludge pumped through the line or dislodged by the scraper.

Saponification Number (Sap. No.) The number of milligrams of potassium hydroxide required to saponify 1 gram of sample oil or ester under certain test conditions, as given in ASTM Method D-94.

Saturated Hydrocarbon. A hydrocarbon of such composition that the valence, or combining power, of all carbon atoms present is fully satisfied. Such a hydrocarbon is a stable substance and does not oxidize readily. The degree of unsaturation is a measure of instability.

Saybolt Chromometer. See Chromometer.

Saybolt Color. A scale for the determination of the color of gasoline and burning oils.

Saybolt Viscosity. See Viscosity, Saybolt Furol and Universal.

Scale. 1. A tool or instrument with a series of marks along a line at regulated or graduated distances, used for

871

measuring or computing. 2. A formation of oxide in a flaky film or in thin layers.

Schedule. A monthly, weekly, or daily plan of deliveries from a pipeline at intermediate and pipehead terminals in terms of required dates and sizes of batches. Schedules must be translated into daily pumping orders for actual control of pipeline operations.

Scraper. A device propelled by the moving stream in a pipeline intended to scrape out or dislodge corrosion, wax, sediment, or other deposits that tend to increase friction loss, reduce throughput, or lead to contamination of product. Scrapers are dispatched from and received in scraper traps. The outgoing barrel is on the discharge side of a pump station, and the incoming barrel is on the suction side. The sandtrap is intended to catch the material removed by the scraper. Other terms for scraper are pig or go-devil.

Screen. A filter, sieve, or barrier made of meshed wire or perforated metal, intended to remove solid matter from a flowing stream or to segregate sizes of solid matter. The size of matter removed or segregated depends upon the size of mesh or perforations.

Screwed Fitting. Threaded fitting. A pipe fitting that joins pipe or other fittings by means of external or male threads and internal or female threads.

Seasonal Balancing. Adjusting the volatile components of fuels that affect starting characteristics in an automobile engine to compensate for seasonal temperature changes.

Seconds (as applied to Saybolt Viscosity). The number of seconds required for a given quantity of oil (60 cc) to flow through a standard orifice at specified temperature (usually 100°, 130°, and 210° F.). The Saybolt Furol second (SFS) and Saybolt Universal second (SUS) are measures of viscosity. (See Viscosity, Saybolt.)

Sediment. Foreign matter other than water that settles to the bottom of a container.

Segregator. Filter/separator or water separator. A device for removing water from a stream of product.

894

Seizing. Binding of moving parts that operate one within the other because of lubrication failure or overheating.

Series Connection. Pumps are said to be connected in series when product goes first through one unit and then the next; pumps in series deliver the volume of one pump at the cumulative pressure of all pumps connected; contrasted with parallel connection, in which all units connected receive product simultaneously. A pump manifolded for series operation might deliver 200 barrels per hour at 200 pounds per square inch; while the same unit manifold for parallel operation might deliver 400 barrels per hour at 100 pounds per square inch. (See Stage.)

Service Elbow. Street elbow or ell; a pipe fitting that forms an elbow and has one opening with male threads and one opening with female threads.

Settling Time. The elapsed time that a product remains undisturbed or unagitated between receipt of product into and discharge from storage.

Shear. Displacement of parallel surfaces in opposite directions. (See Rate of Shear.)

Shell. The tank proper of a railway tank car or tank truck; shell capacity refers to the amount of product a tank car holds when the shell is full, that is, when product just touches the underside of the top of the shell; additional product in a tank car then becomes dome innage; shell innage refers to the depth of product in a tank car; shell outage refers to the distance from the underside of the top of the shell to the level of product; dome innage and shell outage are not applied to tank trucks; capacity of a tank truck refers to the amount of product in the vehicle when the level of product reaches one of two markers commonly installed beneath the dome of each compartment; the higher marker is for highway travel, and lower marker is for cross-country travel.

Shutdown. A total stoppage of operations; a pipeline may be shut down because of a line break or because of a lack of product or ullage; a line should be shut down under positive pressure to keep the line full and to help control the spread of interfaces.

Simplex Pump. See Pump, Simplex.

Single Acting Pump. See Pump, Single Acting.

Siphon. A tube bent into two legs of unequal length and used to transfer liquid from a container at one elevation to a container at a lower elevation; a necessary condition is that the liquid must first be raised in the shorter leg higher than the sidewalls of the first container; the system must first be filled before flow can take place; flow then begins because the greater weight of liquid in the longer leg overbalances the weight of liquid in the shorter leg; atmospheric pressure keeps the shorter leg filled and flow continues as long as the inlet is covered.

Skidmore Crucible. An iron crucible used in making the Conradson carbon residue test (ASTM D-189).

Slack Line. A pipeline that has been shut down under static pressure only, or such static pressure in the product as may exist because of differences in elevation along the profile.

Slate. A report used by the military service for listing requirements of petroleum. The petroleum products written slate is a stock status and planned requirements report compiled monthly by an oversea commander to requisition bulk petroleum products and certain packaged fuels. The petroleum products message slate is an advanced requirements report submitted monthly by electrical transmission by Joint Petroleum Offices and later confirmed by a written slate. There are two types:

Overseas Bulk Petroleum Products Slate (Overseas Slate). The planned five-month delivery requirements for overseas ports or ocean terminals. It is submitted by Unified Commands (JPO) via AUTODIN to DFSC.

CONUS Bulk Petroleum Products Slate (CONUS Slate). The planned four-month delivery requirements for CONUS tanker discharge ports or ocean terminals. It is prepared by DFSC Field Offices and is normally developed from data submitted by service activities within the area of responsibility of the individual field offices.

Slated Items. High usage petroleum products, either bulk products or packaged petroleum fuels, identified in Federal Supply Catalog C9100-ML Vol. I, which are slated (requisitioned) for use overseas only through Joint Petroleum Office (JPO) channels.

Slop. Any liquid petroleum product known to be off specification; storage tanks may be reserved for such products while waiting for analysis, reclamation, or other disposition; interfaces not disposed of in the adjacent products, or not fit for such disposition, should be taken off in slop tanks pending disposition.

Slop Tanks. Tanks regularly containing products which are not up to quality, or those products which are to be treated or degraded and transferred to selected tanks.

Slow Curing Cutback. Asphalt thinned with kerosene or a similar solvent for convenience in road work; slow evaporation of the solvent delays hardening or curing of the surface.

Sludge. A heavy sedimentation or deposit on the bottoms of storage tanks consisting of water, dirt, and other settlings; gunk. Crude oils and residuals form the heaviest sludges, and light products form lesser sludges. Engine sludge is a particular kind of sludge containing products of combustion deposited in internal combustion engines.

Smoke Point. The maximum height in millimeters of the flame of a test lamp at which a jet fuel will burn without smoking (ASTM D-1322).

Soluble. Capable of dissolving or passing into solution; solubility is the extent of being soluble, usually expressed as the weight in grams of a substance, the solute, that can be dissolved in 100 milliliters of a solvent to form a solution.

Soluble Cutting Oil. An industrial term used to describe a mineral oil containing an emulsifier, making it capable of mixing with water to form a coolant for metal-cutting tools.

Solute. The substance dissolved in a solvent to form a solution.

Solution. A uniform mixture of a solute in a solvent from which the solute can be separated by crystallization or other physical means; called a physical solution when no chemical changes take place; otherwise called a chemical solution.

Sour. A term applied to gasolines, naphthas, and refined oils that show a positive doctor test, that is, contain hydrogen sulfide or mercaptans.

Source Identification and Ordering Authorization Form (SIOATH). The SIOATH is a form used to advise the supply source (contractor or terminal) of the activities authorized to order or requisition product from that source and the target quantity to be withdrawn by each. It also advises the ordering activities of all the supply data necessary to schedule product and place a proper order.

Spark Ignition Engine. An internal combustion engine in which the air-vapor mixture is ignited by a timed spark from a spark plug; contrasted with compression ignition engine (diesel).

Specific Gravity (Sp. Gr.). The ratio of the weight of any quantity of matter, a petroleum product for example, to the weight of an equal quantity of water; usually determined by use of a hydrometer. (See API Gravity.) The formula for converting specific gravity to degrees API gravity is as follows:

$$\text{Specific gravity} = \frac{141.5}{{}^\circ\,\text{API} + 131.5}$$

Specific Heat. The ratio of the quantity of heat required to raise the temperature of a body 1° to that required to raise an equal mass of water 1°.

Specification. Prescribed limits of control tests used to maintain uniformity of a specific product.

Spectrometric Oil Analysis. The detection, by spectrometer, of wear metals in regularly taken samples of used oils from oil-wetted mechanical systems. By examining the wear metals, the rate of friction wear of the various metal parts of the mechanical system can be determined. (See Ware Metal.)

Splitloading. Carrying more than one product in a compartmented tank vehicle; the different products are mixed when delivered through a common discharge system.

Spontaneous Combustion. Self-ignition of combustible material caused by accumulation of heat through slow oxidation; cannot take place if the heat is dissipated as fast as it is generated.

Spontaneous Ignition Temperature. See Autogenous Ignition Temperature.

Spray. A jet or stream of liquid broken up in small droplets; the first step in forming the air-vapor mixture in a carburetor, a spray being more easily vaporized than a solid stream.

Stable Emulsion. A suspension of one substance within another that does not separate readily on standing; depending upon whether an emulsion is desired, agents can be added that tend to stabilize the suspension.

Stability. Refers to resistance to chemical change in petroleum products, saturated hydrocarbons being more stable than unsaturated; gum or oxidation stability is the resistance of a gasoline to forming gum in storage due to oxidation.

Stage. Grade, level, or step, as in the case of liquid passing through an impeller of a pumping unit having more than one impeller; standard military pumping units are single-stage, two-stage, and four-stage; four-stage pumping units can be operated with stages in series only, but two-stage pumping units can be operated with stages in parallel or in series.

Standardization Fuels. Fuels that are highly sensitive to changes in engine operating conditions. Such fuels are not intended for making octane ratings, but only for checking engine operating conditions.

Standby. A term for equipment used only in emergencies or on a rotational basis as in the case of pumping units in a pump station, for uniformity of wear and for maintenance purposes.

Standpipe. A high, vertical pipe used as a reservoir and as a means of maintaining a uniform pressure in a supply system.

Starlifter. A C-141 Air Force transport aircraft.

Starting Ease. Refers to the initial volatility of a gasoline that vaporizes and ignites readily for easy starting.

Static Electricity. Stationary, electric potential generated by friction between unlike substances and in the atmosphere; contrasted with voltaic or current electricity.

Static Pressure. Hydrostatic pressure produced with a column of liquid because of weight alone; measured by feet of head.

Stave Sheet. A curved, steel plate or stave used to make up the sidewalls of a tank. (See Ring.)

Stoddard Solvent. A petroleum distillate, water-white or not darker than 21, maximum end point 410 degrees F. and minimum flashpoint 100 degrees F., used for drycleaning (ASTM D-484).

Stoke. A unit of kinematic viscosity. (See Centistoke and Viscosity, Kinematic.)

Storage Capacity. Total of existing bulk tankage assigned for product storage. Capacity is measured to maximum fill level for each tank and includes non-recoverable tank bottoms.

Storage Solubility. A measure of separation that takes place in universal gear lubricants after storage and centrifuging (FTM No. 3455).

Straight Run Gasoline. Gasoline produced directly from crude oil or from an uncracked distillate by distillation and without cracking.

Strainer. A screen, sieve, or filter.

Strapping. Determining the volume of storage tanks at regular intervals of depth by careful measurements and allowing for lost volume from deadwood; the more accurate the strapping of a tank the more accurate gaging can be.

Stratification. The condition that may arise in a storage tank which has received batches of product of different gravities wherein the heavier product settles to a layer on the bottom, instead of mixing with the lighter product.

Streamline Flow. Laminar Flow. (See Critical Velocity.)

Street Elbow. See Service Elbow.

Stripping. In pipeline operations, the process of drawing off a part of the total capacity of the pipeline into regulating tankage. Some tankers are equipped with a stripping system which is used for stripping the tanks dry of ballast.

Stuffing Box. A chamber that can be packed liquid tight and that permits passage and lengthwise or rotary movement of a piston rod, shaft, valve stem, or similar moving part.

Subarea Petroleum Office (SAPO). A suboffice of a Joint Petroleum Office (JPO) established by the JPO to fulfill petroleum logistics responsibilities in a section of the geographical area for which the JPO is responsible. (See Joint Petroleum Office.)

Suction. An effect of atmospheric pressure; pumps cannot exert a negative force on liquids in the intake line; they can only exhaust or pump out the air from the line, and atmospheric pressure, acting on the source of supply, pushes or lifts liquid up to the pump. The limit of such a lift is the height to which a force of 14.7 pounds per square inch can raise the product; reciprocating pumps can pump air better than centrifugal pumps, and it is for this reason that centrifugal pumps usually have to be primed, or filled with product to displace the air. Suction pressure should be understood to mean pressure on the suction side of the pump.

Sulfated Residue Test. A method of determining the concentration of known metal-containing additives in new lubricating oils (ASTM D-874).

Sulfur Tests. Determination of sulfur in petroleum products using a wick lamp is described in FTM No. 5201.7; determination of sulfur in products that cannot be burned completely in a wick lamp is described in ASTM D-129.

Sump. A depression or low place on the floor of a storage tank or in a piece of equipment intended to aid removal of sediment and water.

Supercharge Method. A method for determining the knock-limited power, under supercharge rich-mixture conditions, of fuels for use in spark-ignition aircraft engines. It is carried out as prescribed in ASTM D-909. The knock characteristics of the fuels are expressed as octane numbers below 100 and as performance numbers above 100.

Supercharger. A compressor of the rotary-vane or centrifugal type used to supply air or air-vapor mixture to an internal combustion engine at a pressure greater than atmospheric to improve volumetric efficiency; usually driven by the engine itself or by an exhaust gas turbine.

Surfactant. A surface active agent which enhances fuel/water emulsification and can interfere with removal of entrained water from fuels.

Surge Pressure. A rapid increase in pressure in a flowing stream caused by the too rapid closing of a valve; a surge tank or chamber is a receiver intended to absorb or to compensate for sudden fluctuations in pressure.

Suspension. Dispersion in a liquid or in a gas of small particles of a solid substance or of small droplets of a liquid; *smoke* is a suspension of particles of carbon in gases of combustion; *fumes* are a suspension of solid particles in air; *fog* is a dense suspension of water droplets in air; *mist* is a less dense suspension of water droplets in air; an *emulsion* is a suspension of oil droplets in water or of water droplets in oil.

Sweet. A term applied to petroleum products that show a negative doctor test, that is, do not contain hydrogen sulfide or mercaptans.

Switching Tanks. Changing from one tank to another when pumping or receiving product.

Tagliabue (Tag) Closed Tester. Apparatus for determining flashpoints of all liquids flashing below 175° F.

Tank. A storage container for liquid products; tankage refers to tanks collectively; tank car is a cylindrical metal tank mounted on a frame and on railway freight car trucks; tank bottoms are the contents below the suction or drawoff line; tank or tank car heater is a steam coil on the tank bottom used to reduce viscosity for easy handling of product; tank farm is a group of storage tanks connected by pipe and manifold; tank gaging is measurement of innage or outage and observation of temperature and specific gravity to determine volume of contents at 60° F.; tank truck (or semitrailer) is a tank shell mounted on a chassis for highway travel; tank and pump unit (FSN 4930-542-2800) is an assemblage of small-sized tanks and a dispenser assembly suitable for mounting in a cargo truck. (Also see Gross Tank Capacity, Innage, Inventory, Maximum Fill Level, Non-Recoverable Tank Bottom, Outage, Shell Capacity, Storage Capacity, Ullage, Usable Inventory, Usable Storage Capacity, and Variable Vapor Space.)

Tanker. A seagoing vessel for transportation of liquids. Coastal tankers have less draft (depth of a ship below the water line) than ocean-going tankers. (See Barge and Y-Boat.)

Technical. A term used in connection with laboratory products to designate a high grade commercial chemical.

Tee. A pipe fitting with an outlet on each end of the main run and a side outlet at right angles to the main run.

Teletype. A form of telegraph using a device like a typewriter that can be operated at a distance; a form of communication between the chief dispatcher and district dispatchers and pump stations; a teletypewriter is the printing device used.

Temperature. Degree of heat or cold as measured by thermometer; temperature centigrade (C) is measured on a scale on which water freezes at 0° and boils at 100°; temperature Fahrenheit (F) is measured on a scale on which water freezes at 32° and boils at 212°; temperature measurements are described in ASTM D-1086. Volumetric measurements of petroleum products are always corrected to 60° F. for bulk deliveries of 3,500 gallons or more.

Tempering Oil. A high viscosity, straight mineral oil used for drawing or tempering metal; strictly speaking, a quenching oil is used for cooling metal quickly for hardening, and a tempering oil is used for cooling metal slowly to an intermediate state between hardening and annealing.

Tender. A quantity of product offered to a carrier for shipment; a tender may be moved in one or more batches. (See Batch.)

Tentative Method. A term applied by the American Society for Testing and Materials to a method that has been approved for use preliminary to adoption as a standard.

Terminal. A bulk facility for receipt, storage, transportation, and issue of petroleum products; may be a base terminal for receipt and shipment of product by tanker, a pipehead terminal at the downstream end of the pipeline, or an intermediate terminal on the pipeline; consists of a tank farm or tank farm complex, tank farm manifold, and a central pump station area.

Tested Purity (TP). A term in connection with the purity designation of a laboratory reagent to show that the indicated quality has been tested. (See Degree of Purity.)

Tetraethyllead (TEL): A volatile lead compound developed to improve antiknock rating of gasoline (ASTM D-526). (See Lead Susceptibility.)

Tetramethyllead (TML). Another lead compound used for the same purpose as TEL. The new compound is more volatile and has a slower rate of reaction during combustion which makes it more effective than TEL and less is required.

Thermal Efficiency. The ratio of the heat used to the total heat units in the fuel consumed.

Thermal Jet Engine. A power unit in which air is taken in from the atmosphere, heated by combustion of a hydrocarbon and then exhausted at a greater velocity than that at which it was taken in. (See Turbojet Engine.)

Thermal Stability. The resistance to change caused by heat, FTM No. 2503.1 for grease, and FTM No. 3461.1 for boiler fuel oil.

Thermal Value. A calorific value, calories per gram or British thermal units per pound or gallon (ASTM D-240).

Thermocouple. An electrical device for measuring temperature; consists of two wires of different metals joined together; when the junction is heated, a current is generated and the amount is proportioned to the temperature. A thermopile is the same kind of device, but more sensitive, consisting of several dissimilar metals arranged alternately.

Thermometer. A device for measuring temperature or degrees of heat or cold; may depend upon the expansion of mercury or liquids or change in electrical conductivity; see FTM 9501.4 for specifications.

Thermostat. An automatic device for regulating temperature.

Thief. See Bacon Bomb and Sampler.

Thiefing. Taking a sample from a specified point in a container.

Thinner. A diluent; a hydrocarbon mixture in the gasoline and kerosene range used as a solvent.

Three-Way Valve. A valve, usually of the plug type, with three ports so arranged that fluid entering by one port can be directed through either of the other two ports by positioning the plug by means of a handle.

Throttling Valve. A valve used to regulate flow, to permit passage of any desired part of the full stream; a globe or needle valve is the most satisfactory type of throttling valve because there is no unbalanced pressure acting on the disk or needle point when either valve is open, hence no uneven wear or errosion; needle valves are used for more delicate throttling than globe valves; a gate valve, intended to be fully closed or fully open, is unsatisfactory as a throttling valve because the face of the disk is exposed to uneven wear or errosion when the valve is partly open.

Throughput. Capacity; quantity transported per unit of time; barrels per day or gallons per minute.

Timken Film Strength. A test of gear lubricants made on the Timken extreme pressure (EP) machine.

Tintometer. See Chromometer.

Titration. A method of chemical analysis; consists in adding a measured volume of an unknown to a known volume or weight of a standard substance until a change in color is observed; the change indicates the beginning or end of a chemical reaction; the amount of the unknown under test needed to produce this effect can be calculated, and from the result, the quality or strength of the unknown can be determined.

Tolerance. An allowable variation from a specified limit; a blending tolerance, for example, is the greatest percentage of a substance that can be added to a product without putting the product too far off specification.

Top Sample. A sample taken about 6 inches below the surface of the tank contents.

Torsion Viscosimeter. An instrument for measuring viscosity using disk suspended from the lower end of a wire; when the wire is twisted, or put in torsion, and the disk is suspended in a sample, the liquid tends to damp or retard the swinging back and forth of the disk; the amount of damping is proportional to the viscosity of the sample.

Trace. An amount large enough to be detected, but not to be measured.

Transformer Oil. See Insulating Oil.

Transmission Oil. Gear oil grade 75, 80, 90, and 140 made to Specification MIL-L-2105 and gear oil made to Specification MIL-L-10324 for subzero use.

Trenching. Ditching or excavating around a tank or other equipment to form a trap for product in case of rupture or overflow; similar in purpose to a dike.

Triplex Pump. A reciprocating pump with three liquid cylinders.

Trunk Line. The main line of a pipeline or telephone system, railroad, etc.; trunk station is a pump station on the main pipeline.

Tubing. Pipe manufactured of light gage steel (thin walls), aluminum, brass, or copper; in military usage the material is referred to as standard, lightweight tubing, and it has Victaulic couplings; steel tubing is supplied in 4-, 6-, 8-, and 12-inch nominal sizes, and aluminum tubing is supplied in 4-, 6-, and 8-inch nominal sizes; brass and copper tubing in small sizes are used for hydraulic, refrigeration, and lubrication lines, and for other applications.

Turbine Oil. Lubricating oil for steam turbines, military symbol 2190TEP, made to Specification MIL-L-17331.

Turbojet Engine. An engine in which air is compressed by a rotating compressor, is heated by fuel combustion at compressor pressure, released through a gas turbine which drives the compressor, and finally ejected at high velocity through the rearward exhaust nozzle.

Turbulent Flow. The state of flow in which the streamline or forward motion of fluid is broken up into eddies, swirls, and cross motions; the state in which flow can be described as chaotic; said to exist when the Reynolds number is greater than 4,000.

Turkey Red Oil. Castor oil treated with sulfuric acid and used as an emulsifying agent for compounded oils.

Turnaround. The length of time between arrival at a point and departure from that point; refers to the time required for a highway vehicle, railroad car, or waterborne vessel to load or discharge cargo; the turnaround time or cycle includes loading time, traveling to destination, unloading time, reloading time if any, return travel, and unloading time if any, thus being ready for the beginning of another cycle.

Ubbelohde Viscosimeter. An apparatus for determining kinematic viscosity with great accuracy (ASTM D-445).

Ullage. The amount which a tank, container, or vessel lacks of being full (see Outage); a term generally used in connection with ships' tanks.

Union. A type of coupling for small sizes of pipe; consists of two threaded, nipple-like members fitted together in a seat tightened by a single nut.

United States Pharmacopoeia (USP). A board that establishes requirements for the purity of products used for medical purposes; a product designated USP meets all such requirements; a purity designation often associated with reagents used in the petroleum laboratory.

Unsaturated Hydrocarbon. An unsaturate; a hydrocarbon with a molecular structure containing one or more double or triple links between adjacent carbon members; olefins and aromatics are the principal groups of such substances; being unsaturated, these substances are also unstable, and are more capable of undergoing change than the saturates (paraffins and naphthenes); oxidation is an example of undesirabl; change in a product.

Upgrade. 1. A grade that slopes upward in the direction of pipeline flow. 2. To change service from a dark or heavy product to a light or volatile product, refers to the nature of a product stored in a tank or transported in a tanker, tank car, or tank truck. 3. To blend a higher grade gasoline interface into tankage containing a lower grade gasoline.

Upper Sample. A sample taken from the middle of the upper third of the tank contents.

Upstream. Opposite to the direction of pipeline flow; contrasted with downstream or the direction of pipeline flow.

Usable Inventory. Inventory contained between non-recoverable tank bottom and current product level, (excluding pipeline fill).

Usable Storage Capacity. That part of storage capacity from maximum fill level to, but not including, non-recoverable tank bottoms for tanks currently in service.

Use Limits. Tolerances established by MIL-HDBK-200B to permit use, under certain conditions, of products that do not fully meet specifications.

Vacuum. A space entirely devoid of matter (called specifically "absolute vacuum"); a space, as the interior of a closed vessel, exhausted to some degree by an air pump or other artificial means. (Any vacuum less than absolute is a partial vacuum.) When a pump removes a part of the air from its suction line (creates a partial vacuum), atmospheric pressure lifts fluid up to the intake; the theoretical limit of this lift (in the case of a perfect vacuum), is the height to which the fluid can be lifted by a pressure of 14.7 pounds per square inch (atmospheric pressure at sea level).

Vacuum-Breaking Valve. A valve with an action opposite to that of a relief valve; an exterior pressure higher than that within the closed vessel operates to open the valve in order to equalize the pressures; the operating valves on most truck loading racks have such a vacuum breaker.

Valence. The combining power of an element.

Valve. A device used to control flow of fluids.

Vane. Any of several flat or curved pieces set around an axle or arbor to be rotated by or to move a fluid stream.

Vapor. The gas-like form of a substance that is normally a solid or a liquid; any gaseous substance that can be condensed by cooling or compression; vapor density is the relative weight of a gas or vapor compared with the weight of an equal volume of a standard substance like air or hydrogen; vapor lock is a condition in a fuel system, or in a pumping system, in which vaporized fuel, or product, is blocking or retarding flow of fuel to the carburetor, or flow of product through the pump; vapor pressure is the pressure in a closed vessel exerted by the vapors released from any volatile product at a given temperature (ASTM D-323); vapor space is the free area in a container above the level of the product; vapor testing is a means of detecting the presence of flammable gas or vapor and measuring its concentration by means of a gas detector; vaporization is the conversion of a liquid to its vapor, or evaporation.

Variable Vapor Space. Refers to the vapor space in tanks specially constructed for storage of volatile products; (these tanks usually have a baloon roof, a breather roof, or a lifter roof (gasometer)); the vapor space is described as variable because the tank roof moves up or down with the expansion or contraction of the confined vapors.

887

Velocity of Flow. Rate of flow measured usually in feet per second equal to volume of flow in cubic feet per second divided by the cross sectional area of the pipe in square feet; velocity head is the head in feet equivalent to the velocity in feet per second; equal to the square of the velocity divided by twice the acceleration of gravity in feet per second (64.3).

Vent. An opening in a tank or other container that permits inflow of air during periods of falling temperature or when pumping or pouring from the container and the exit of air and vapor during periods of rising temperature or when filling the container. Some vents have controls that are set to prevent intake of air or release of vapors until the vacuum or pressure reaches a critical point.

Venturi Tube. Two short sections of pipe of decreasing diameter joined at the small ends by a shorter section of straight pipe called the throat; its purpose stems from the fact that with a given volume of flow through pipe of decreasing diameter, pressure decreases and velocity of flow increases; the large end of the venturi and the throat are connected by tubing to some form of manometer, permitting pressures to be measured; the device is used to meter volume of flow (venturi meter) or to create suction at the point of maximum velocity.

Viscosimeter. Viscometer; a device used to measure viscosity or internal resistance to flow; examples are Saybolt Universal and Saybolt Furol (ASTM D-88), and Ubbelohde (ASTM D-445). (See Torsion Viscosimeter.)

Viscosity. Internal resistance to flow; usually measured as time in seconds for a given quantity of sample to flow through a standard capillary tube; viscosity index is a means of rating resistance to change in viscosity with change in temperature; oils of high viscosity index are more resistant to change; oils of low viscosity index thicken quickly when chilled and thin out too much when hot. The following definitions of viscosity are used in petroleum laboratories:

Viscosity, Absolute. The force which will move 1 square centimeter of plane surface with a speed of 1 centimeter per second relative to another parallel plane surface from which it is separated by a layer of the liquid 1 centimeter thick. This viscosity

910

is expressed in dynes per square centimeter, its unit being the poise, which is equal to 1 dyne-second per square centimeter. A unit of one-hundredth of a poise, designated as a centipoise, is of more convenient magnitude, and is commonly used. (See Centipoise and Poise.)

Viscosity, Kinematic. The kinematic viscosity is defined as the absolute viscosity divided by the density at the temperature of the viscosity measurement. The metric units of kinematic viscosity are the stoke and centistoke, which correspond to the poise and centipoise of absolute viscosity. (See Centistoke and Stoke.)

Viscosity, Saybolt Furol. A viscosity test similar in nature to the Saybolt Universal viscosity test, but one more appropriate for testing high-viscosity oils. Certain transmission and gear oils and heavy fuel oils are rated by this method. The results obtained are approximately one-tenth the viscosity which would be shown by the Saybolt Universal method. (See Seconds.)

Viscosity, Saybolt Universal. The time, in seconds, for 60 milliliters of fluid to flow through a capillary tube in a Saybolt viscosimeter under specified conditions. (See Seconds.)

Viscous. Heavy, thick-bodied, gluey, or slow in motion.

Volatile. Tending to evaporate or vaporize readily; volatility is the extent to which a liquid vaporizes or the ease with which it turns to vapor.

Volume Correction. The correction of measured quantity of product, determined by gaging at observed temperature and gravity and reference to a gage table, to net quantity of product at 60° F. after deducting bottom water and sediment.

Volumetric Efficiency. 1. The ratio of volume delivered from the discharge of a pump or compressor to the volume displaced by the pistons or plungers. 2. The ratio of volume of air-vapor mixture that actually enters an engine cylinder to the volume that could enter under ideal conditions.

Volute. The cavity of increasing volume into which the impeller of a centrifugal pump discharges and in which velocity head is converted to pressure head.

Ware Metal. Traces of metals worn off metal mechanical parts by friction. (See Spectrometric Oil Analysis.)

Water. An odorless, colorless, transparent liquid compound, H_2O. Water in fuels is described as follows:

Water, Dissolved. All fuel will contain water in solution but the amount will vary considerably as the temperature of the fuel varies [illegible] A rule-of-thumb estimate of the amount can [illegible] made by stating that the water-saturation value [illegible]he fuel is equal to PPM (parts per million) by volume to the fuel temperature in degrees Fahrenheit. The percent of dissolved water can only be determined by a laboratory test such as the Karl Fischer analysis. This water cannot be separated from fuel by filtration or by mechanical means.

Water, Entrained. "Free" water which is suspended throughout a fuel sample and has not settled to the bottom of the container is considered "entrained" water.

Water, Free. All water present in the fuel which has not been dissolved by the fuel is considered "free" water. This water should be separated from fuel by ground servicing equipment.

Water and Sediment. A test method of determining water and sediment in crude oil and fuel oils by centrifuge (ASTM D-96).

Water Bottom. Any part of the tank below the suction line left filled with water because of leakage; more generally, that part of the tank occupied by water and sediment.

Water by Distillation. A test method of determining water in a sample of bituminous material by distillation with a volatile solvent (ASTM D-95).

Water Contamination. Water present in a fuel in any form; includes dissolved water similar to moisture in the air, entrained water suspended in the form of minute droplets, and free water.

Water Drawoff. A sump and drain line or a drain line with valve used to draw off water from a tank without disturbing the product.

Water Hammer. Hydraulic shock; the sudden increase in pressure or the surge effect, and the hammer-like jar resulting from closing a valve and stopping a flowing stream too rapidly.

Water Immersion. A method of determining the stability of grease in the presence of hot water (FTM No. 3463).

Water Indicating Paste. A preparation which changes color on contact with water and is applied to the innage bob or gaging tape; purpose of the paste is to aid in measuring quantities of product and water.

Water Resistance. A method of determining the ability of a grease to resist the washing action of water in rotating ball bearings (ASTM-1264).

Water Separator. Segregator; a filtering device that separates or segregates water from a flowing stream by coalescence.

Water Soluble Oil. A cutting oil with the property of forming a permanent emulsion; made to Specification VV-C-846 and used as a coolant and lubricant for metal-cutting tools.

Waterproof Grease. A grease that does not dissolve in water and that resists being washed out of bearings or off of gears better than other types of grease; more properly termed water resistant.

Water Test. A method of testing a newly completed pipeline; line should be blocked off in sections and clean, fresh water pumped until the maximum working pressure is reached; pressure is observed for a period of 24 hours when possible.

Water-White. A grade of color in oil; defined as plus 21 or higher in the Saybolt chromometer scale.

Water-White Distillate. A kerosene cut, or refined oil cut, coming from crude stills, before this distillate is treated or rerun.

Weak Acid. An acid that ionizes little and yields few hydrogen ions in aqueous solution; for example, acetic acid.

Weathering. Loss of the most volatile components of crude oils and light products during storage and handling, and the formation of products of oxidation.

Weekly Tanker Terminal Status Report. A message report which provides DFSC with pertinent data on present and projected bulk POL terminal status.

Westphal Balance. A device in which the buoyance of a float is balanced by sliding weights; used for determining specific gravity of liquids.

Wet Gas. A gas that contains a relatively high proportion of hydrocarbons recoverable as liquid products.

Wetting Agent. A substance added to a liquid to increase its spreading quality on a surface or its penetrating quality in a material; added to water, the substance makes a more effective fire extinguishing agent.

Wet-Wing. A technique of air-delivering petroleum in which an aircraft (usually a C-130) uses its own fuel tanks as containers to move fuel to a forward area. At the forward area all fuel in the aircraft's tanks, except that required for the return trip, is pumped out into storage tanks.

Wick Feed Lubrication. Lubricating oil supplied to a bearing by feeding it through a wick of twisted fibers; retention of siphoning power in an oil is determined by FTM No. 2001.2.

WOG Pipe Fitting. A pipe fitting suitable for water, oil, or gas.

Worked Penetration. A test method of determining penetration (consistency) of lubricating grease after mechanical working (FTM No. 313.2).

Y-Boat. A self-propelled barge-type boat used to transport liquids. The large Y-boat (capacity: 11,079.8 U.S. barrels) has nine tanks for liquid cargo and one dry-cargo hatch; the small Y-boat (capacity: 6,711.3 U.S. barrels) has six tanks for liquid cargo and one dry-cargo hatch. (See Barge and Tanker.)

SECTION II

ABBREVIATIONS

(Note: An asterisk by an abbreviation indicates that standard usage outside the Government omits the periods from the abbreviation, i.e., B.t.u. is used in Government-printed materials for British thermal unit but Btu is used by commercial and scientific publications.)

a.	ampere (Government publications)
*a.c.	alternating current
ACS	American Chemical Society
amp.	ampere (non-Government publications)
ANSI	American National Standards Institute
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AVFUELS	aviation fuels
AVGAS	aviation gasoline
bbl.	barrel
*b.p.	boiling point
b.p.h.	barrels per hour
BS&W	bottom sediment and water
BT	bottle (unit of issue)
*B.t.u.	British thermal unit
BU	bundle (unit of issue)
BX	box (unit of issue)

C.	centigrade
cal.	calorie, small (see Calorie, definition 1)
Cal.	calorie, large (see Calorie, definition 2)
cc.	cubic centimeter
CCP	critical compression pressure
CCR	closed circuit refueling (for rotary wing aircraft)
ccw	counterclockwise
CFR	Coordinating Fuel and Equipment Research Committee of the Coordinating Research Council, Inc.
cm.	centimeter
CN	can (unit of issue)
*c.p.	chemically pure
cres	corrosion resistant steel
CT	carton (unit of issue)
DFSC	Defense Fuel Supply Center
DFSP	Defense Fuel Support Point
DGSC	Defense General Supply Center
DODAAC	Department of Defense Activity Address Code
dp	dry point
DSA	Defense Supply Agency
DZ	dozen (unit of issue)
EA	each (unit of issue)
ep	end point
EP	extreme pressure
F.	Farenheit

895

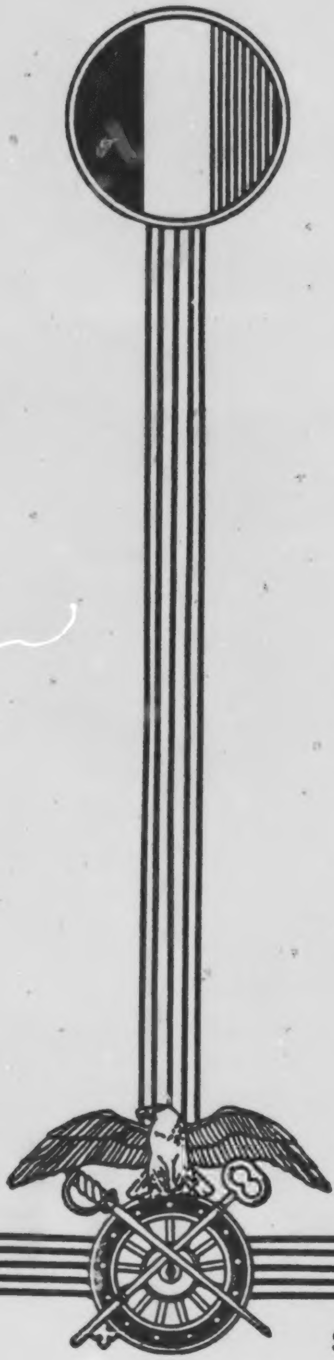
FARE	forward air refueling equipment
fbp	final boiling point
FSII	fuel system icing inhibitor
FSN	Federal stock number
FTM No.	Federal Test Method Number
FTMS	Federal Test Method Standard
gal.	gallon
GL	gallon (unit of issue)
*g.p.h.	gallons per hour
*g.p.m.	gallons per minute
HUCR	highest useful compression ratio
ibp	initial boiling point
ID	inside diameter
IEOAP	Interservice Equipment Oil Analysis Program
IL	identification list
IP	Institute of Petroleum (London)
IPS	iron pipe size
ivp	initial vapor point
JP fuel	jet propulsion fuel
JPO	Joint Petroleum Office
JR	jar (unit of issue)
l.	liter
LPG	liquefied petroleum gas
MEK	methylethyl ketone

μ	micron
mg.	milligram
ml.	milliliter
mm.	millimeter
MOGAS	automotive gasoline
*m.p.	melting point
N-BR	nitrile-butadiene rubber (originally called Buna N)
NPRA	National Petroleum Refiners Association
OD	outside diameter
OFO	Oversea Field Office of DFSC
PG	package (unit of issue)
PN	performance number
POL	petroleum, oils, and lubricants
*p.p.m.	parts per million
*p.s.i.	pounds per square inch
*p.s.i.g.	pounds per square inch gage
PT	pint (unit of issue)
QT	quart (unit of issue)
Re	Reynolds number
*r.p.m.	revolutions per minute
Rvp	Reid vapor pressure (sometimes RVP)
SAE	Society of Automotive Engineers
SAPO	Subarea Petroleum Office
Sap. No.	Saponification Number

SE	set (unit of issue)
SFS	Saybolt Furol second
SIOATH	Source Identification and Ordering Authorization Form
SOAP	Spectrometric Oil Analysis Program
Spec.	specification
Sp. Gr.	specific gravity (in Government publications)
*sp. gr.	specific gravity (in non-Government publications)
SUS	Saybolt Universal second
Tag.	former C.J. Tagliabue Manufacturing Co., manufacturer of testing apparatus
TEL	tetraethyllead
TML	tetramethyllead
TP	tested purity
u/i	unit of issue
USP	United States Pharmacopoeia
WOG	water, oil, or gas

898

NIPUB 358(PE/EXAM)



PETROLEUM SUPPLY SPECIALIST
MOS 76W10

PRACTICAL EXERCISES AND EXAMINATIONS

U.S. ARMY QUARTERMASTER SCHOOL
FORT LEE, VIRGINIA

SUPPLY TRAINING CENTER OF THE ARMY SCHOOL SYSTEM
ATSM-DT-TM-OT-ET
MAY 1978
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921

SECTION I

THE ARMY MAINTENANCE MANAGEMENT SYSTEM (TAMMS)

SITUATION #1

YOU HAVE JUST COMPLETED AFTER OPERATION MAINTENANCE ON A POL PUMP, THERE WERE NO EQUIPMENT FAULTS, HOWEVER YOU ADDED 1 QUART OF OIL AND 5 GALLONS OF GASOLINE. THE HOUR READING ON THE PUMP IS 230.

ACTION REQUIRED

SELECT CORRECT FORM IN INCLOSURE #1 AND MAKE APPROPRIATE ENTRIES

SITUATION #2:

AS THE OPERATOR OF A POL PUMP, YOU HAVE BEEN PROVIDED A DA FORM 2400. THE DISPATCHER HAS COMPLETED HIS PORTION OF THE FORM AND HAS HAD YOU SIGN IT. TIME OUT IS 0800 HOURS; TIME IN IS 1600 HOURS; THE TACHHOUR METER HAD A READING OF 120 HOURS AT COMPLETION OF OPERATION:

ACTION REQUIRED:

MAKE APPROPRIATE ENTRIES TO DA FORM 2400 IN INCLOSURE #1.

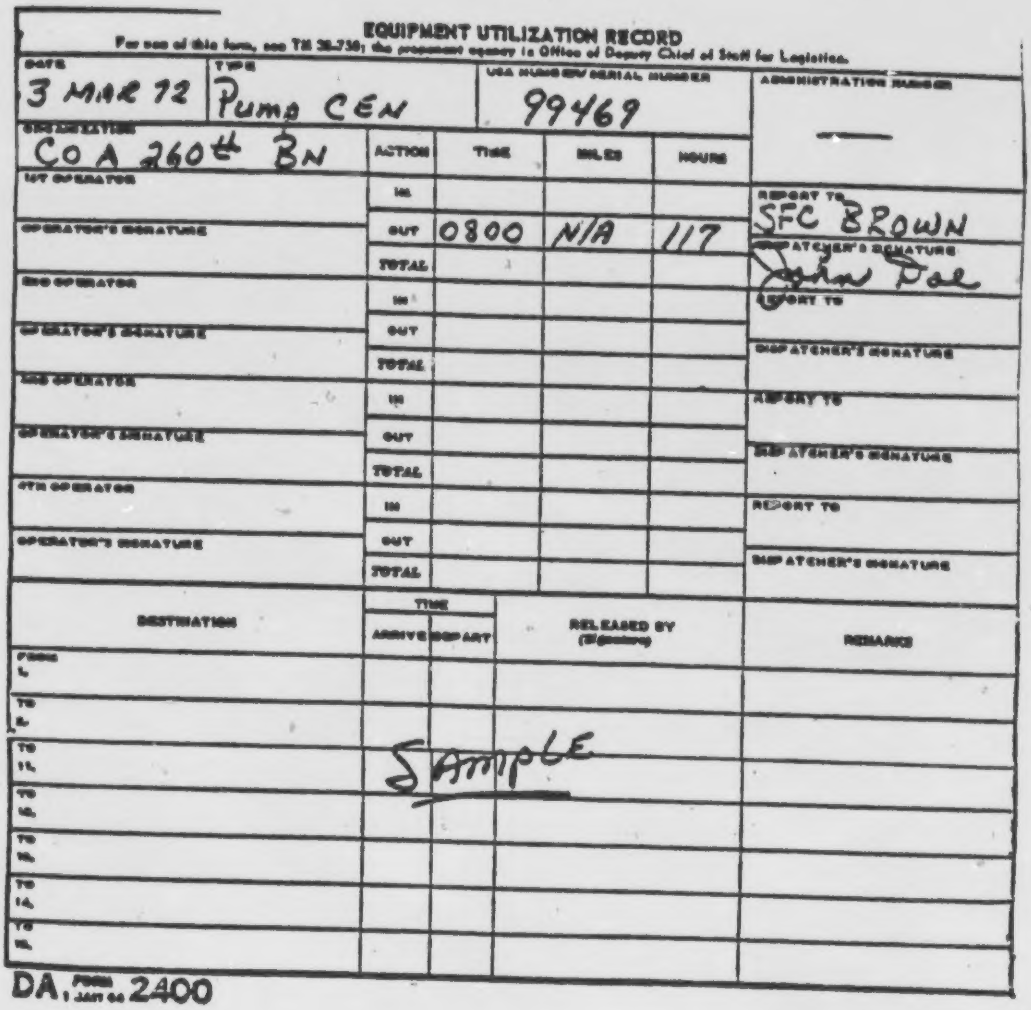
SITUATION #3:

DURING ROUTINE OPERATOR'S MAINTENANCE ON A POL PUMP, YOU FOUND A LEAKING RADIATOR AND A BROKEN BATTERY TERMINAL. YOU REPLACED THE FAULTY BATTERY, HOWEVER, YOU COULD NOT REPAIR THE LEAKING RADIATOR. TM ITEM NUMBER FOR THE BATTERY IS 12 AND RADIATOR ITEM NUMBER IS 4. PUMP CAN BE OPERATED FOR LIMITED PERIODS.

ACTION REQUIRED:

SELECT CORRECT FORM(S) IN INCLOSURE #1 AND MAKE APPROPRIATE ENTRIES.

EQUIPMENT LOGBOOK



EQUIPMENT UTILIZATION RECORD

For use of this form, see TM 38-750; the proponent agency is Office of Deputy Chief of Staff for Logistics.

DATE: 3 MAR 72
TYPE: Pump CEN
USA NUMBER/SERIAL NUMBER: 99469
ADMINISTRATION NUMBER: —
ORGANIZATION: CO A 260th BN

	ACTION	TIME	MILES	HOURS	
1ST OPERATOR	IN				REPORT TO: SFC BROWN
OPERATOR'S SIGNATURE	OUT	0800	N/A	117	DISPATCHER'S SIGNATURE: John Doe
	TOTAL				
2ND OPERATOR	IN				REPORT TO
OPERATOR'S SIGNATURE	OUT				DISPATCHER'S SIGNATURE
	TOTAL				
3RD OPERATOR	IN				REPORT TO
OPERATOR'S SIGNATURE	OUT				DISPATCHER'S SIGNATURE
	TOTAL				
4TH OPERATOR	IN				REPORT TO
OPERATOR'S SIGNATURE	OUT				DISPATCHER'S SIGNATURE
	TOTAL				

DESTINATION	TIME		RELEASED BY (Signature)	REMARKS
	ARRIVE	DEPART		
FROM 1.				
TO 2.				
TO 11.				
TO 12.				
TO 13.				
TO 14.				
TO 15.				

SAMPLE

DA FORM 1 JAN 64 2400

For use of this form, see TM 38-750; the proponent agency is Office of the Deputy Chief of Staff for Logistics.

1. NOMENCLATURE Pump CEN

2. REGISTRATION OR SERIAL NUMBER 99469

3 NEXT SERVICE OR LUBRICATION DUE a. TYPE b. HOURS/MILES c. DATE

4. TYPE LOG ☒ DAILY ☐ MONTHLY

				OIL CHANGED OR ADDED (Ch or qts) e				OPERATIONAL STATUS f			SERVICE OR LUB h		OTHER ACTIONS i			NONAVAILABLE DAYS				
DATE OF ENTRY	READING HOURS	READING MILES	TOTAL FUEL ADDED (Gals)	ENGINE	TRANSMISSION			EQUIPMENT FAULTS	IS EQUIPMENT OPERATIONAL*	SIGNATURE OF OPERATOR OR CREW CHIEF	TYPE	COMPLETE*				ORG MAINT		SUPPORT MAINT		SIGNATURE OF INDIVIDUAL MAKING ENTRIES OTHER THAN OPERATOR OR CREW CHIEF
a	b	c	d							g						S	M	S	M	k

SAMPLE

5

DA FORM 2408-1, 1 May 67

REPLACES EDITION OF 1 JAN 64 AND
DA FORM 2408-2 1 APR 62 WHICH ARE OBSOLETE.

EQUIPMENT DAILY OR MONTHLY LOG

1. NOMENCLATURE PUMP CEN

2. MODEL USPL

3. SERIAL NUMBER 99469

STATUS SYMBOL a	FAULT b	REASON FOR DELAY c	DATE (From DA Form 2404 or 2408-13) d	ENTRY APPROVED (Signature) e	DATE (To DA Form 2408-1, 2401, or 2408-13) f

SAMPLE

DA FORM 2408-14, 1 JAN 64 For use of this form, see TM 38-750; proponent agency is Deputy Chief of Staff for Logistics. UNCORRECTED FAULT RECORD

EQUIPMENT INSPECTION AND MAINTENANCE WORKSHEET
(TM 38-750)

1. ORGANIZATION: CO A 260 TH BN
2. NOMENCLATURE AND MODEL: Pump CEN
3. REGISTRATION/SERIAL/FSN: 99469
4a. MILES:
b. HOURS:
c. ROUNDS FIRED:
d. HOT STARTS:
5. DATE:
6. TYPE INSPECTION: OPERATORS

APPLICABLE REFERENCE

TM NUMBER: TM 5-4320-200-15
TM DATE: Nov-68
TM NUMBER:
TM DATE:

INSTRUCTIONS—Perform each check listed in the TM applicable to the inspection performed. Following the sequence listed in pertinent TM, complete form as follows:

COLUMN a—Enter TM item number.
COLUMN b—Enter the applicable condition status symbol.
COLUMN c—Enter deficiencies and shortcomings.
COLUMN d—Show corrective action for deficiency or shortcoming listed in Column c.
COLUMN e—Individual ascertaining completed corrective action initial in this column.

ALL INSPECTIONS AND EQUIPMENT CONDITIONS RECORDED ON THIS FORM HAVE BEEN DETERMINED IN ACCORDANCE WITH DIAGNOSTIC PROCEDURES AND STANDARDS IN THE TM CITED HEREON.

8a. SIGNATURE (Person(s) performing inspection):
8b. TIME:
9a. SIGNATURE (Maintenance Supervisor):
9b. TIME:
10. MANHOURS REQUIRED:

TM ITEM NO a	STATUS b	DEFICIENCIES AND SHORTCOMINGS c	CORRECTIVE ACTION d	INITIAL WHEN CORRECTED e

SAMPLE

DA FORM 1 JAN 64 2404

SECTION II
FIRE FIGHTING EQUIPMENT AND PROCEDURES

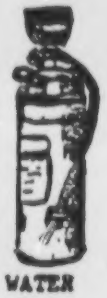
SITUATION #1:

YOU HAVE RECENTLY BEEN APPOINTED AS THE BUILDING FIRE MARSHAL OF A NEWLY CONSTRUCTED WOODEN OFFICE BUILDING IN A CLASS III YARD. ONE OF YOUR RESPONSIBILITIES IS TO OBTAIN FIRE EXTINGUISHERS TO BE PLACED AT KEY POINTS THROUGHOUT THE BUILDING.

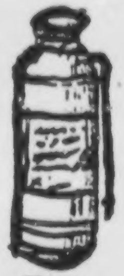
ACTION REQUIRED:

SELECT THE TYPE OF FIRE EXTINGUISHER SHOWN BELOW THAT YOU WOULD OBTAIN FOR THE BUILDING.

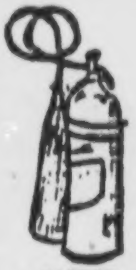
ANSWER______________________



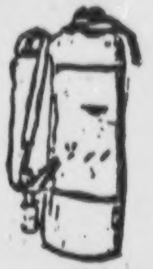
WATER PUMP



FOAM



CARBON DIOXIDE



DRY CHEMICAL

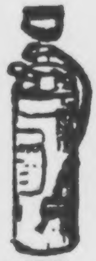
SITUATION #2:

YOU HAVE BEEN ASSIGNED AS FIRE AND SAFETY NCO FOR A PETROLEUM STORAGE LOCATION. UPON MAKING A SAFETY INSPECTION OF YOUR AREA, YOU OBSERVED AN EXTREME SHORTAGE OF FIRE EXTINGUISHERS. AS FIRE AND SAFETY NCO, IT IS YOUR RESPONSIBILITY TO OBTAIN SUFFICIENT EXTINGUISHERS.

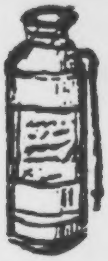
ACTION REQUIRED:

SELECT THE TYPE OF FIRE EXTINGUISHER SHOWN BELOW THAT YOU WOULD OBTAIN FOR THE STORAGE LOCATION.

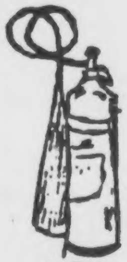
ANSWER____________________



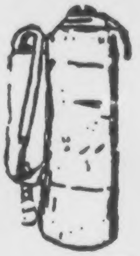
WATER PUMP



FOAM



CARBON DIOXIDE



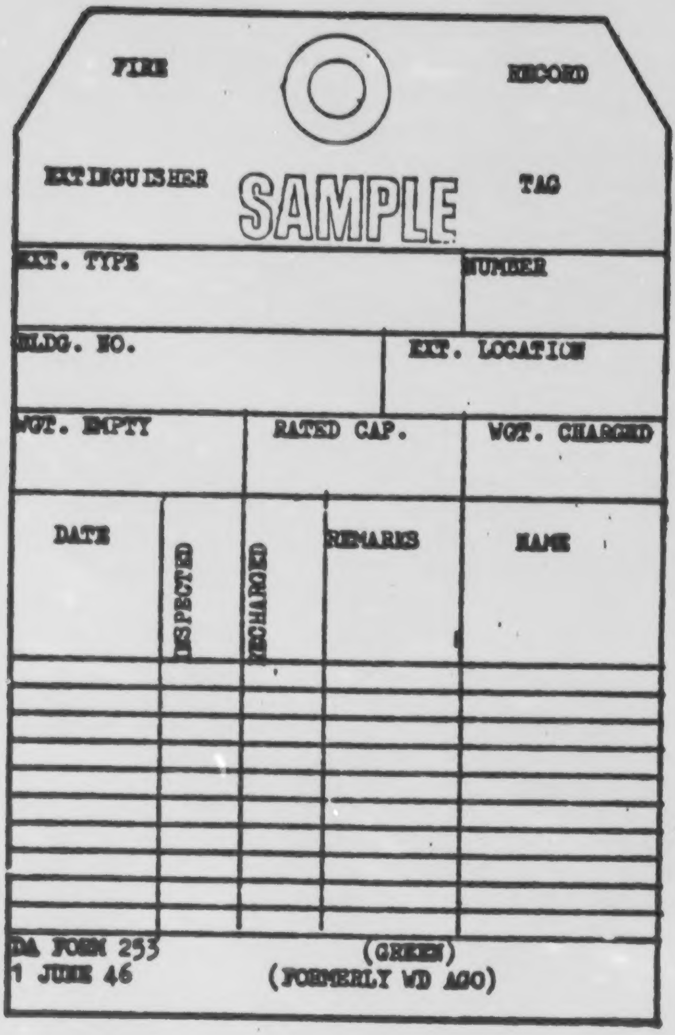
DRY CHEMICAL

SITUATION #3:

YOU HAVE BEEN ASSIGNED AS FIRE AND SAFETY NCO FOR A PETROLEUM STORAGE LOCATION. AS FIRE AND SAFETY NCO, ONE OF YOUR RESPONSIBILITIES IS TO PERFORM MONTHLY INSPECTION OF ALL FIRE EXTINGUISHERS IN YOUR AREA OF RESPONSIBILITY.

ACTION REQUIRED:

INSPECT FIRE EXTINGUISHER PROVIDED AND COMPLETE MONTHLY FIRE EXTINGUISHER INSPECTION TAG.



FIRE RECORD

EXTINGUISHER TAG

SAMPLE

EXT. TYPE				NUMBER
BLDG. NO.			EXT. LOCATION	
WGT. EMPTY		RATED CAP.		WGT. CHARGED
DATE	INSPECTED	RECHARGED	REMARKS	NAME

DA FORM 253 (GREEN)
1 JUNE 46 (FORMERLY WD AGO)

SECTION III

VISUAL CONTAMINATION & EXAMINATION

	VALUE	SCORE
Read instructions carefully. Work at your own pace.		
1. Answer the following questions.		
a. When performing a visual examination what are the three things you must report?		
______________________________	4	____
______________________________	4	____
______________________________	4	____
b. What is the color of each of the following fuels?		
(1) AVGAS (Grade 100LL) ____________________	5	____
(2) MOGAS (Combat) ____________________	5	____
(3) JP-4 ____________________	5	____
(4) Diesel Fuel ____________________	5	____
c. What are the four major fuel contaminants?		
______________________________	4	____
______________________________	4	____
______________________________	4	____
______________________________	4	____

PROPONENT DEPARTMENT: Patroleum & Field Services
November 1976

911

PSS-C2-PEE

NAME ______________________________

Instructor give student authorization (DA Form 2404).

	VALUE	SCORE
SAFETY CHECK - DID THE STUDENT...		
1. Place CO_2 fire extinguisher in work area	2	
2. Place "No Smoking" signs in work area	2	
Ground the pump (procedure)		
3. -ground rod placed in ground (3 ft)	2	
4. -connect ground cable from ground rod to pump	2	
BEFORE OPERATIONAL CHECKS - DID THE STUDENT...		
1. Check discharge nozzles and screen	2	
2. Check discharge hose	2	
3. Check oil level (add as required)	2	
4. Check fuel tank and sediment bowl (add as required)	2	
5. Check oil bath air cleaner (add or change as required)	2	
6. Check suction hose	2	
7. Check starter rope	2	
SET UP - DID THE STUDENT...		
1. Connect suction hose to the pump suction port	2	
2. Connect suction hose to source of supply	2	
3. Connect discharge hose to pump discharge port	2	
4. Connect nozzle to discharge hose	2	
OPERATION - DID THE STUDENT...		
1. Prime or flood pump	2	
2. Open source of supply	2	
3. Starting procedure		
-check the choke	2	
-open fuel shut off valve	2	
-position speed control level 1/2 way	2	
-pull magneto switch down	2	
-wind starter rope on pulley (clockwise) pull starter rope	2	
4. After engine start		
-warm pump for 5 to 10 minutes	2	
5. Bleed off air in hose	2	
6. Increase engine speed	2	
7. Fill container to proper fill level	2	

935

	VALUE	SCORE
DURING OPERATION - DID THE STUDENT...		
1. Check for noise	2	
2. Check for leak(s)	2	
SHUT DOWN PROCEDURE - DID THE STUDENT...		
1. Idle engine down	2	
2. Allow engine to cool for 3 to 5 minutes at idle	2	
3. Shut off source of supply	2	
4. Disconnect suction hose from source of supply	2	
5. Elevate suction hose and walk into pump	2	
6. Disconnect suction hose and replace dust caps and dust plugs on pump and hoses	2	
7. Push in magneto switch to stop engine	2	
8. Close the fuel shut off valve	2	
9. Disconnect discharge hose and replace dust caps and dust plug	2	
10. Drain discharge hose into container	2	
11. Remove nozzles and replace dust caps and dust plugs	2	
AFTER OPERATION - DID THE STUDENT...		
1. Perform after operational maintenance	2	
2. Check discharge nozzles and screen	2	
3. Check discharge hose	2	
4. Check oil level (add as required)	2	
5. Check fuel tank and sediment bowl (add as required)	2	
6. Check oil bath air cleaner (add or change as required)	2	
7. Check suction hose	2	
8. Check starter rope	2	
9. Complete entries on DA Form 2404	2	
PACK ASSEMBLY AWAY - DID THE STUDENT...		
1. Clean equipment	2	
2. Place equipment in carrying case	2	
	Total--100	

OBJECTIVE:

The student, when provided with two 600-gallon tanks, pumping assembly, and 5- or 2-1/2-ton cargo trucks, will be able to:

1. Install tank and pump unit on 5- or 2-1/2-ton cargo trucks.
2. Know the major components of the tank and pump assembly.
3. Perform operator's maintenance on the tank and pump unit.
4. Operate tank and pump unit in fueling and defueling operations.

Exam worth: 15 points
Items worth: as shown

PROPONENT DEPARTMENT: Petrl & Fld Svcs Dept

November 1976

Performance Examination
Tank & Pump Unit

1. Before operations. (Instructor will advise student to do everything he is supposed to do prior to leaving motor pool with the tank and pump unit. Check if he does the following).

	VALUE	SCORE
a. Inspect & gage the tanks	2	
b. Check nozzle strainers	3	
c. Drain manual water drain	3	
d. Check hoses & ground cable	2	
e. Check gas, oil, air cleaner sediment bowl	3	
f. Set out fire extinguisher	2	
g. Ground the vehicle	2	
h. Start the pump	5	
i. Recirculate the fuel	5	
j. Check pressure differential	3	

2. Operation of the Tank & Pump Unit (Instructor will ask student to properly fill a 55 gal drum using proper techniques and then take the fuel out of the drum and put it back in the tank. (Check if he does the following).

	VALUE	SCORE
a. Properly place fire extinguisher	2	
b. Ground the vehicle	2	
c. Use proper valve settings	8	
d. Start & operate the pump	8	
e. Maintain metal to metal contact	5	
f. Fill drum to proper level	3	
g. Connect hose properly for defueling	6	
h. Prime pump properly	8	
i. Proper valve setting for defueling	8	

3. After Operations. (Instructor will ask student to perform after operations maintenance and check if he does the following).

a.	Return all equipment to proper storage	3	
b.	Close all valves	5	
c.	Check manual water drain	3	
d.	Check oil, gas, air filter	5	
e.	Clean up equipment	2	
f.	Fill out TAMMS forms	2	

9/6

NAME ______________________ CLASS ____________ DATE __________________

	VALUE	SCORE
PHASE 1 ---------------------- 350 GPM Pump		
1. Before Operation Maintenance.		
a. Check fuel level	4	
b. Check oil	4	
c. Check air cleaner	4	
d. Check Y strainer	5	
e. Ground pump	3	
f. Placement of fire extinguisher	3	
2. Operation of 350 GPM pump.		
a. Open suction valve	5	
b. Start pump engine	5	
c. Adjust RPM and warm up	3	
d. Pumping operation	10	
e. Stopping pumping operation	5	
3. After Operation maintenance.		
a. Check fuel level	4	
b. Check oil	4	
c. Check air cleaner	4	
d. Complete DA Form 2404	4	
PHASE 2 -----------------350 GPM Filter separator		
1. Before operation maintenance.		
a. Check for loose or broken connection of parts	2	
b. Check manual water pump valve and drain water if necessary	3	
c. Placement of fire extinguisher	3	
d. Ground separator	2	
e. Open necessary valves	3	
2. During operation maintenance.		
a. Open manual vent valve until fuel appears	3	
b. Open drain valve pet cock on liquid level to expel trapped air	3	
c. Check for leaks	2	
d. Check pressure differential	5	
3. After operation maintenance.		
a. Open manual water drain valve until fuel appear	3	
b. Close necessary valves	2	
c. Clean exterior of separator	2	

PROPONENT DEPARTMENT : Petroleum and Field Services
Nov 76
SUPERSEDES: PS-C-6-PFS dated May 1976

FUEL SYSTEM SUPPLY POINT	VALUE	SCORE
1. LAYOUT AND ASSEMBLY		
a. Proper hose connections	10	___
b. Proper placement of filter/separators	5	___
c. Proper placement of pumps	5	___
d. Proper positioning of collapsible tanks	5	___
e. Grounding of equipment	5	___
f. Placement of fire extinguishers	5	___
2. MAINTENANCE		
a. Make temporary repairs to tanks	5	___
b. Check hoses for leaks and deterioration	5	___
c. Check valves for leaks and proper operations.	5	___
3. OPERATION		
a. Receive product from tank vehicle		
(1) Proper manifold valves used	10	___
(2) Proper operation of pump and filter separator	5	___
b. Transfer fuel from one tank to another tank		
(1) Proper manifold valves used	10	___
(2) Proper operation of pump and filter separator	5	___
c. Filling petroleum containers/vehicles		
(1) Proper manifold valves used	10	___
(2) Proper operation of pump and filter separator	5	___
d. After operation maintenance, cleanup and storage	5	___

PART I

OBJECTIVES:

As a result of the instructions in this lesson and when provided with a M131, 5,000 gallon semi-trailer, the student will be able to:

1. Perform operator's maintenance on the semi-trailer.

2. Operate the manifold, auxilary pump and components of the semi-trailer to perform on-loading and off-loading operations observing all safety precautions.

PART II

OBJECTIVES:

As a result of this instruction, you, the student will be able to:

1. Perform operator's maintenance on the tank vehicle.

2. Circulate fuel and record pressure differential.

3. Fuel and defuel petroleum containers using the tank vehicles.

EXAM WORTH: 20 points

ITEM WEIGHTS: as shown

PART I

Performance Examination
M 131 Tank Trailer

1. Before operations:	VALUE	SCORE
a. Check gage compartments	3	
b. Engine compartments (battery, oil, gas, etc)	3	
c. Leaks, damaged or missing parts	2	
d. Check fire extinguisher and ground cables	2	

2. During operations (Instructor will ask student to identify proper hose connections and valve setting for the following operations).

a. Bottom loading from 350 pump at FSSP	10	
b. Bottom loading using pump on the trailer	10	
c. Discharging from trailer thru 3 inch discharge port	10	

3. Operation. (Instructor will ask student to circulate 500 gal of fuel from a tank compartment back into the same tank using the 225 GPM dispensing hose. Then check if the student did the following).

a. Placement of fire extinguisher	3	
b. Connection of ground cable	3	
c. Proper valve setting	10	
d. Check nozzle strainer	5	
e. Before operations maintenance on pump	5	
f. Proper starting & operation of pump	10	
g. Operate nozzle correctly	5	
h. Check pressure differential	5	

4. After operations.

a. Close all valves	6	
b. Check on engine compartment	2	
c. Proper storage of equipment	2	
d. Clean up any spills or leaks	2	
e. Complete TAMMS forms as required	2	

PS-C-9-PFS 920

Name ______________________________

PERFORMANCE EXAMINATION

AIRCRAFT REFUELING

STATEMENT

The work submitted herein is my own work; I have neither given nor received unauthorized assistance; and I have seen no evidence of cheating in any form throughout this examination, other than that which I have or will report to proper authority.

____
Signature

PROPONENT DEPARTMENT: Petrl & Fld Svcs

Dec 76

PART 1

M49A2C

The instructor will advise the student that he will put ten (10) gallons of fuel in the aircraft using an M49A2C observing all proper operational and safety techniques, and perform before, during, and after operations maintenance on the vehicle. The instructor will evaluate the following:

1. Before Operations:	Value	Score
a. Spot the vehicle.	3	
b. Check hoses and ground cable.	2	
c. Place fire extinguishers.	2	
d. Ground the vehicle.	4	
e. Inspect and gage the tanks.	3	
f. Check nozzle strainer.	3	
g. Drain manual water drain.	2	
h. Open automatic drain valve.	2	
i. Recirculate fuel.	5	
j. Check and record pressure differential.	5	
2. Operations:		
a. Engage pump properly.	3	
b. Use proper valve settings for discharge.	5	
c. Bond and ground (at aircraft) in correct sequence.	3	
d. Put ten (10) gallons in aircraft (+1 - one gallon).	5	
e. Disconnect (at aircraft) in correct sequence.	3	

3. After Operations:

	Value	Score
a. Return all equipment to proper storage place.	2	
b. Close all valves.	3	
c. Check manual water drain	2	
d. Clean up any spills or leaks.	1	
e. Fill out TAMMS Forms.	2	

PART II

FARES

		Value	Score
1.	Layout:		
	a. Placement of fire extinguisher.	2	
	b. Layout and connection of pump and F/S.	3	
	c. Proper grounding.	2	
	d. Layout and connection of drums.	3	
	e. Layout of dispensing hoses and nozzles.	2	
2.	Operation:		
	a. Before operations checks on pumps.	3	
	b. Before operations checks on F/S.	3	
	c. Check nozzles (operation and screens).	2	
	d. Proper connection at aircraft.	2	
	e. Operation of pump and F/S.	5	
3.	After Operations:		
	a. Drain hoses.	2	
	b. Drain F/S.	2	
	c. After operations check on pump.	3	
	d. After operations check on F/S.	3	
	e. Proper storage of components.	1	

EXAM WORTH: 10 Points

EACH ITEM: 2.5 Points

OBJECTIVE:

1. Given ASTM Table 6, the API at 60°F and the observed temperature of a volume of products, you will be able to locate the conversion factor for volume correction.

2. Once you have found the conversion factor you will be able to convert a volume at an observed temperature to the volume at 60°F.

3. You will be able to correctly report the calculated volume at 60°F.

925

PERFORMANCE EXAMINATION

VOLUME CORRECTION

Below are four (4) problems which will test your ability to perform calculations for volume correction.

Provided is a strapping chart for a 500 bbl tank for your use. If you have not done so already, take out your Table 6, reduction of volume to 60°F against API gravity at 60°F.

You may use an electronic calculator if you wish but you must show the set-up of each problem encountered in the space provided.

Type of Storage Tank: 500 barrels
Observed API Gravity: 56.2 API
Observed Temperature: 55°F
Innage measurement: 7' 10 3/4"
BS&W Measurement: 3 3/4"

a. What is the total measured quantity? (Innage)

Type of Storage Tank: 500 barrel
Observed API Gravity: 48.4°API
Observed Temperature: 68°F
Innage Measurement: 7' 2 1/2"
BS&W Measurement: 1 1/8"
Your total measured quantity is 19,635.5 gal

b. What is the net volume uncorrected?

PROPONENT DEPARTMENT: Petroleum & Field Services
PUBLICATION DATE: September 1976

Type of Storage Tank: 500 barrel
Observed API Gravity: 45.5°API
Observed Temperature. 50°F
Innage Measurement: 6' 10 3/8"
BS&W Measurement: 2"
Your net volume uncorrected is 16,245.125 gal

c. What is the net volume corrected to 60°F?

Type of Storage Tank: 500 barrel
Observed API Gravity: 49.6°API
Observed Temperature: 65°F
Innage Measurement: 7' 7 1/2"
BS&W Measurement: 1 1/2"

d. What is the net volume corrected to 60°F?

STRAPPING CHART*
500 BARREL TANK

INNAGE		GALLONS	INNAGE		GALLONS	INNAGE		GALLONS
0'	1"	227	3'	0"	8,172	6'	0"	16,344
	2"	454		1"	8,399		1"	16,571
	3"	681		2"	8,626		2"	16,798
	4"	908		3"	8,853		3"	17,025
	5"	1,135		4"	9,080		4"	17,252
	6"	1,362		5"	9,307		5"	17,479
	7"	1,589		6"	9,534		6"	17,706
	8"	1,816		7"	9,761		7"	17,933
	9"	2,043		8"	9,988		8"	18,160
	10"	2,270		9"	10,215		9"	18,387
	11"	2,497		10"	10,442		10"	18,614
				11"	10,669		11"	18,841
1'	0"	2,724	4'	0"	10,896	7'	0"	19,061
	1"	2,951		1"	11,123		1"	19,295
	2"	3,178		2"	11,350		2"	19,522
	3"	3,405		3"	11,577		3"	19,749
	4"	3,632		4"	11,804		4"	19,976
	5"	3,859		5"	12,031		5"	20,203
	6"	4,086		6"	12,252		6"	20,430
	7"	4,313		7"	12,485		7"	20,657
	8"	4,540		8"	12,712		8"	20,884
	9"	4,767		9"	12,939		9"	21,111
	10"	4,994		10"	13,166		10"	21,338
	11"	5,221		11"	13,393		11"	21,565
2'	0"	5,448	5'	0"	13,620	8'	0"	21,793
	1"	5,675		1"	13,847		1"	22,019
	2"	5,902		2"	14,074			
	3"	6,129		3"	14,301			
	4"	6,356		4"	14,528			
	5"	6,583		5"	14,755			
	6"	6,810		6"	14,982	1/8"		28.375
	7"	7,037		7"	15,209	1/4"		56.750
	8"	7,264		8"	15,436	3/8"		85.125
	9"	7,491		9"	15.663	1/2"		113.500
	10"	7,718		10"	15,890	5/8"		141.875
	11"	7,945		11"	16,117	3/4"		170.250
						7/8"		198.625

*To be used for instructional purposes only.

PS-D-11-PFS-E

NAME ______________________

PERFORMANCE EXAMINATION
TERMINAL OPERATIONS

PART I

The instructor will ask the student to gage a storage tank and take the temperature. He will instruct student to take an all level and bottom sample and complete the sample tag on at least one. Evaluate the following.

Task	Allotted % Points	Score
Method & Technique	4	
Safety Precautions	4	
Total Innage Gage	4	
BS&W	4	
Temperature	3	
Bottom Sample	2	
All Level Sample	2	
Sample Tag	2	
TOTAL	25	

929

PS-D-11-PFS-E

NAME ______________________

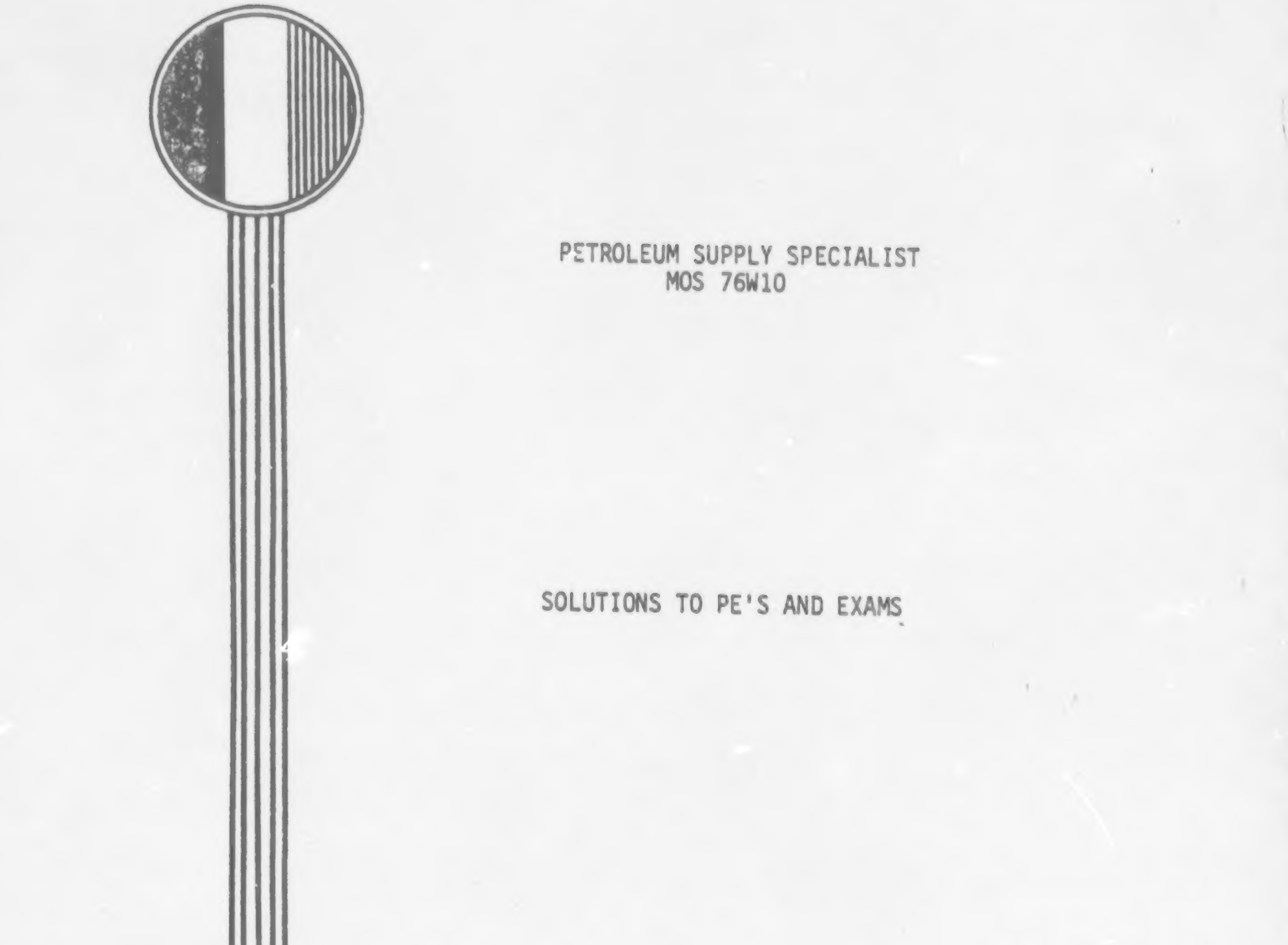
PERFORMANCE EXAMINATION
TERMINAL OPERATIONS

PART II

The instructor will evaluate the Students' knowledge and ability for the following specific tasks or knowledge.

Task	Allotted % Points	Score
Identify Valves	4	
Give Purpose of Valves	3	
Perform Maintenance on Valves	3	
Pipeline Marking Code	3	
Operation of Manifold	4	
Operators Maintenance on Transfer Pump	5	
Operation of Transfer Pump	5	
Safety Check & Inspection of Rail Car	4	
Loading Methods of Rail Car	4	
Unloading Method of Rail Car	3	
Gaging Rail Car	4	
Sampling Rail Car	3	
Fire & Safety Precautions	5	
TOTAL	50	

NIPUB 358(SOL)



PETROLEUM SUPPLY SPECIALIST
MOS 76W10

SOLUTIONS TO PE'S AND EXAMS

U.S. ARMY QUARTERMASTER SCHOOL
FORT LEE, VIRGINIA

SUPPLY TRAINING CENTER OF THE ARMY SCHOOL SYSTEM

ATSM-TNG-TM-ET
MAY 1978

SOLUTION SHEET

SECTION I - TAMMS

Situation #1

Requirement #1

WT		ANSWER
3	a.	DA Form 2408-1
3	b.	Reading Hours, 230
3	c.	Fuel added, five gallons
3	d.	Oil added, engine 1 qt
3	e.	Is equipment operational, check

Ref: TM 38-750, Chap 4, para 4-5

Situation #2

Requirement #1 DA Form 2400

WT		ANSWER
3	a.	First operator, print name
3	b.	Operator signature
3	c.	Time, out 0800, in 1600, total 0800
3	d.	Hours, out 117, in 120, total 3

Ref: TM 38-750, Chap 2, para 2-2

Situation #3

Requirement #1 DA Form 2404

WT		ANSWER
3	a.	Signature block 8a
3	b.	Time block 8a
3	c.	TM item No 4
3	d.	Status Ⓧ
3	e.	Deficiencies, Leaking radiator

Ref: TM 38-750, Chap 3, para 3-4

SECTION II - Fire Fighting Equipment

Situation #1

Requirement #1

WT		ANSWER
3	a.	Water Pump (Ref. TM 10-1101, Chap 16, Sec III)

Situation #2

Requirement #1

WT		ANSWER
3	a.	Foam or carbon dioxide (Ref: TM 10-1101, Chap 16, Sec III)

Situation #3

Requirement #1

WT		ANSWER
3	a.	DA Form 253
3	b.	Ext type, water
3	c.	Building number, present building
3	d.	Weight empty, NA
3	e.	Rate Cap, 2½ gallon
3	f.	Date, present date
3	g.	Inspected: initials
3	h.	Remarks, OK
3	i.	Name, signature

Ref: DA Pam 385-3

SECTION III - Checklist for Visual Contamination

There is no solution for Section III due to the nature of the questions.

PSS-D-3-PFS

VOLUME CORRECTION
SOLUTION SHEET

A. 7' 10" = 21,338.000
+ 170.250

21,508.250 innage (correct answer)

21,508 gallons rounded off (not necessary to round off)

B. Total measured quantity = 19,635.500
- 255.375

19,380.125

19,380 gallons - net volume uncorrected rounded off

C. Round off 45.5° API to 46° API
Multiplier - 1.0051

```
   18,245        net volume uncorrected
 x 1.0051

    18245
   91225
 1824500

18,338.0495  =   18,338 gallons - net volume
                                 corrected
```

D. Innage - 7' 7½" = 20,770.5
- 340.5

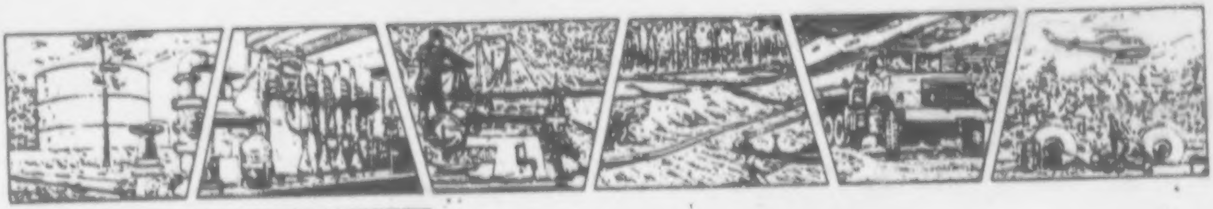
Net volume uncorrected 20,430.0 gallons

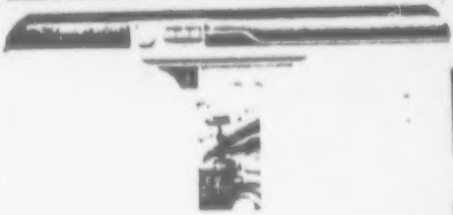
Round off 49.6° API to 50° API

Multiplier = .9973

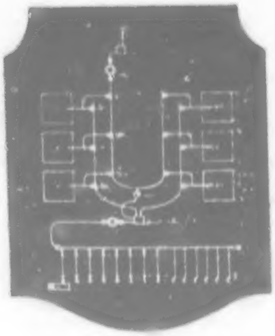
```
   20,430
  x .9973

    61290
   143010
  183870
 183870

20,374.8390  gallons

20,375 gallons - net volume
                 corrected - rounded off
```

FM 10-69





PETROLEUM SUPPLY POINT EQUIPMENT AND OPERATIONS



AREA
PACKAGE PRODUCT STORAGE AREA
RAILROAD

HEADQUARTERS, DEPARTMENT OF THE ARMY

Note: Only the materials of FM 10-69 which are required in the Program of Instruction have been included. Please note that FM 10-69 supersedes TM 10-1101, 1972.

FIELD MANUAL
NO. 10-69

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, D.C., 31 October 1977

PETROLEUM SUPPLY POINT EQUIPMENT AND OPERATIONS

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FOREWORD

This manual is divided into two parts. Part one describes petroleum-handling equipment and its use by TOE units in their general support, direct support, and unit level operations. Part two deals with class III supply point operations. It includes information on safety; quantity and quality control; set up and management of a class III supply point and assault hoseline; receipt, storage, and issue of bulk and packaged petroleum products and fuels; and bulk reduction. This manual is oriented toward tactical field operations and deals with the responsibilities of both management and operator personnel. It can be used in conventional and nuclear warfare. However, the manual cannot be cited as an authority for requisitions. Requisitions must be based on some authority such as tables of allowance or tables of organization and equipment. To recommend changes and suggest improvements, send comments to the Commandant, US Army Quartermaster School, ATTN: ATSM-TD-TL, Fort Lee, Virginia 23801. Comments should be keyed to the specific page, paragraph, and line of the text in which the change is recommended. Provide reasons for each comment so that it can be understood and evaluated.

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*This manual supersedes TM 10-1101, 3 May 1972, including all changes and chapter 6 of FM 10-18, 30 April 1974.

SAFETY PRECAUTIONS

Safety is the first thing you must be aware of when you work with petroleum products. You will often be exposed to fire, health, and explosion hazards. You must know how to protect yourself and use safe working habits so that you won't be injured and property won't be damaged. Chapter 10 of this manual gives safety rules you must know and observe. Some of these rules are outlined in table 1 and each chapter throughout this manual includes some safety rules you must obey.

Table 1. Safety precautions

NO SMOKING	Strictly enforce NO SMOKING rules.
NO SMOKING SIGNS	Post NO SMOKING WITHIN 50 FEET signs where they can be seen.
FIRE EXTINGUISHERS	Place fire extinguishers and other firefighting equipment within easy reach but where they will be safe from a fire.
FLAME- AND SPARK-PRODUCING EQUIPMENT	Don't use open flames, heating stoves, electrical tools, or other such apparatus in petroleum storage and work areas.
EXPLOSIONPROOF EQUIPMENT	Use only authorized tools, equipment, and clothing, and explosionproof lights and flashlights.
TOOLS	Keep tools and equipment in safe and good working condition.
BOND AND GROUND EQUIPMENT	Bond and ground pumps, tank vehicles, and storage tanks.
NOTCHED-HANDLE NOZZLES	Don't use nozzles with notched handles. Tend all nozzles constantly while refueling. If you must use notched-handle nozzles, make sure the notches are modified so that the nozzles must be held open by hand and attended at all times.
SPILLS	Try not to spill fuels. Clean up spills at once. Repair leaks at once. If needed, replace defective hoses, gaskets, and faucets.

CHAPTER 1

PUMPS

HAND-OPERATED PUMPS

One-Quart-Per-Stroke Dispensing Pump

■ **Description.** This pump (fig 1-1) consists of a pump assembly, suction pipe, and discharge tube. It can be installed in a 1 1/2- or 2-inch drum opening and on the 600-gallon, skid-mounted tank. The piston is raised and lowered by a gear-and-rack mechanism which is driven by a crank handle. Turning the handle to make one complete stroke of the piston delivers 1 quart of product. The handle must then be returned to its original position before more product can be delivered. The pump has an adjustable stop so that it does not deliver too much or too little. Product is delivered through a nondrip nozzle, which is positioned to connect with an adjustable swing arm return tube. The return tube lets excess product drain back into the drum through a drain channel located in the pump base. If the work area is not under cover, the pump suction pipe and the drum vent plug must be tightened securely and protected with a waterproof cover when the pump is not in use. This keeps water from seeping through the drum openings and contaminating the product.

■ **Use.** The 1-quart-per-stroke dispensing pump is used chiefly to transfer lubricating oil from 55-gallon drums into smaller containers.

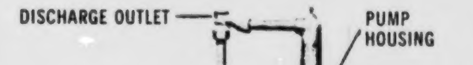


Figure 1-1. 1-quart-per-stroke dispensing pump mounted in a 55-gallon drum.

939

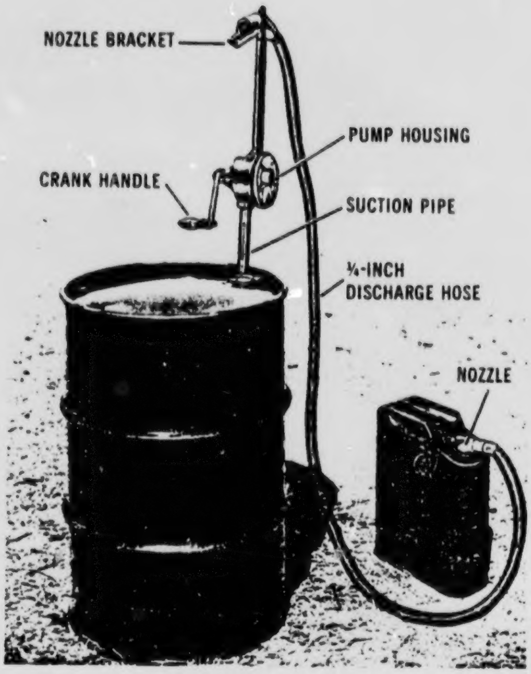


Figure 1-2. 12-gpm hand-driven dispensing pump installed in a 55-gallon drum.

12-gpm Dispensing Pump (100 Cycles Per Minute)

■ **Description.** The 12-gpm pump (fig 1-2) consists of a pump assembly, suction pipe, discharge hose, and valveless nozzle. The pump is designed to be installed in a 1 1/2- or 2-inch drum or tank opening. Depending upon manufacturer's design, the pump may be one of three types: rotary, diaphragm, or piston. The pump discharges through an 8-foot length of 3/4-inch hose with nozzle. When not in use, the nozzle is placed in the nozzle bracket on the discharge fitting. The pump suction pipe must be tightened securely to the drum vent plug and protected with a waterproof cover when the pump is not in use.

■ **Use.** The 12-gpm pump is used to transfer automotive gasoline, kerosene, fuel oil, and diesel fuel from 55-gallon drums, 600-gallon skid-mounted tanks, or other petroleum containers with a 1 1/2- or 2-inch standard straight-pipe thread-bung opening.

15-gpm Dispensing Pump (22 Gallons For 100 Revolutions)

■ **Description.** This unit (fig 1-3) consists of a hand-driven, reciprocating pump, a suction stub assembly, a hose assembly, a nozzle, and a brace assembly. The pump body is mounted to the suction stub assembly, which fits into the 2-inch opening of the drum. The suction stub assembly includes a telescoping suction tube and a threaded bung adapter. The pump is operated by a push-pull action of the lever; the lever drives the piston within the pump, forcing fluid to the pump outlet. The pump discharges through a 20-foot length of 1-inch synthetic rubber hose and a standard nozzle with a 100-mesh wire cloth strainer. A ground wire, equipped with alligator clamp and bonding plug, is attached to the nozzle to permit electrostatic bonding between the nozzle and other equipment. The brace

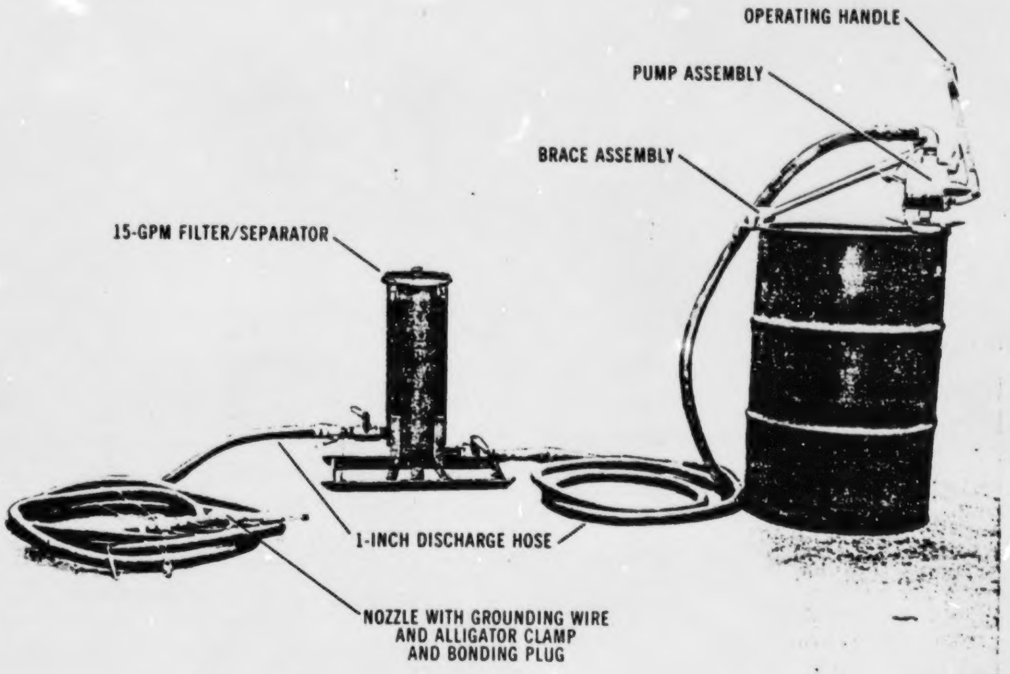

OPERATING HANDLE
PUMP ASSEMBLY
BRACE ASSEMBLY
15-GPM FILTER/SEPARATOR
1-INCH DISCHARGE HOSE
NOZZLE WITH GROUNDING WIRE AND ALLIGATOR CLAMP AND BONDING PLUG

Figure 1-3. 15-gpm hand-driven dispensing pump mounted in a 55-gallon drum and 15-gpm filter/separator connected for refueling aircraft.

941

assembly is attached to the top of the pump and to the chime of the drum to hold the pump securely during pumping operations. A 15-gpm filter/separator that qualifies under MIL-F-8901C must be used with the pump when refueling aircraft. The pump suction pipe of this pump must also be tightened securely to the drum vent plug and protected with a waterproof cover when the pump is not in use. More information on the 15-gpm hand-driven dispensing pump is in TM 10-4930-201-13.

■ **Use.** The 15-gpm pump is used to transfer fuels from 55-gallon drums or 600-gallon skid-mounted tanks direct to equipment fuel tanks. If no other aircraft refueling equipment is available, this pump may be used to refuel light aircraft if a 15-gpm filter/separator is used with the pump. ①

POWER-DRIVEN PUMPS

12- to 15-gpm Dispensing Pump

■ **Description.** The service station pump (fig 1-4) consists of an electrically operated pumping unit mounted on a steel frame and inclosed by sheet-steel panels.

☐ This high-vacuum rotary pump is connected to the motor by a V-belt or coupled directly to the motor shaft extension.

☐ The electric drive motor is usually designed for 115- or 230-volt, 60-cycle, single-phase, alternating-current operation; however, special electrical characteristics are available when required. The motor is rated at one-third horsepower.

☐ The pump discharges product through a wire-reinforced synthetic rubber hose and compound lever-type nozzle. If the nozzle has a lock-on, latch-open device, the device must be made inoperable and fixed so that it can't be locked in the open position. The lever must be held open manually to prevent overfilling and spilling. Between issues, the discharge nozzle is placed in a locking device on the side of the pump body. The locking device also serves as a motor control switch.

■ **Use.** Service station pumps are designed to transfer gasoline from underground storage tanks to equipment fuel tanks. They are usually installed in permanent fuel stations or motor pools where a large number of vehicles are serviced each day. Service station pumps include a 15-gpm pump for light to medium vehicles and a 22- to 25-gpm pump for heavy and tracked vehicles and equipment. The 15- to 25-gpm pumps must not be used to fill storage tanks or compartments of tank trucks.

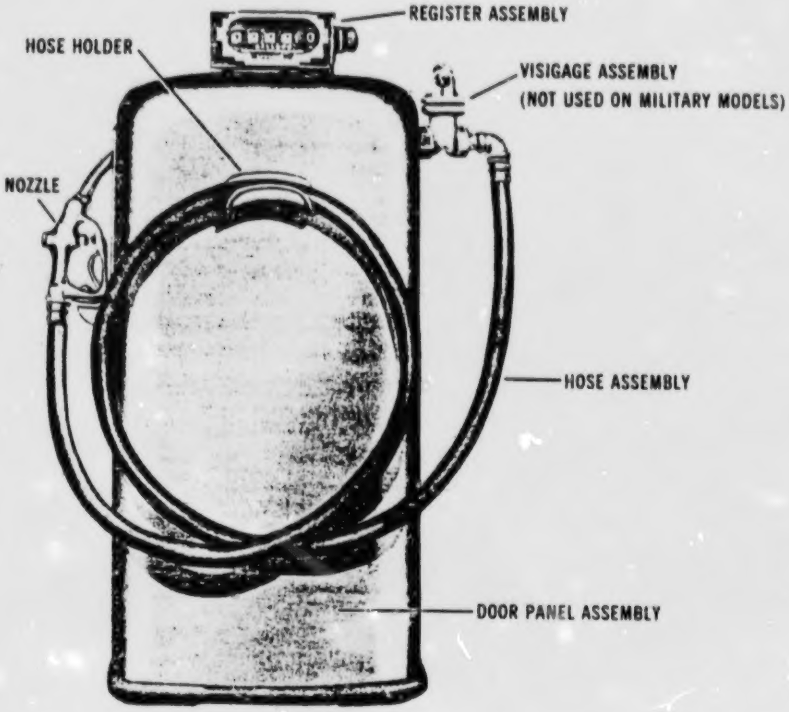

REGISTER ASSEMBLY
HOSE HOLDER
VISIGAGE ASSEMBLY
(NOT USED ON MILITARY MODELS)
NOZZLE
HOSE ASSEMBLY
DOOR PANEL ASSEMBLY

Figure 1-4. Service station dispensing pump.

■ **Inspection.** The pump must be checked each day to make sure there are no leaks, cracks, or broken glass; the housing is firmly anchored; the side panels are in place; the hose bracket is firmly attached; and a nozzle protector is available. The nozzle and hose must be checked often to make sure the nozzle is free of leaks, cracks, or breaks and the lever guide is in place; and the hose is free of cuts and other defects. Defects must be corrected as soon as practicable. In addition, the pump meter must be calibrated as directed in TM 5-678.

50-gpm Gasoline-Engine-Driven Pumping Assembly for Bulk Transfer of Flammable Liquids

■ **Description.** The 50-gpm pumping assembly (fig 1-5) consists of a pump and engine assembly mounted on an oval aluminum base. The assembly has sections of suction and discharge hose, two 1 1/2-inch dispensing nozzles, a drum-unloader suction stub, and two toolboxes containing tools and accessories. The pumping assembly is equipped with a carrying handle and fits into

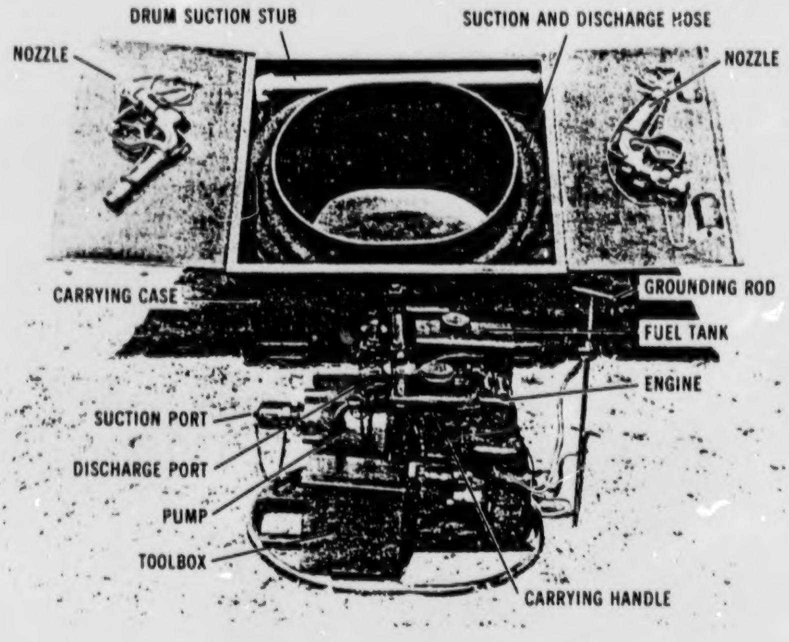

DRUM SUCTION STUB
SUCTION AND DISCHARGE HOSE
NOZZLE
NOZZLE
CARRYING CASE
GROUNDING ROD
FUEL TANK
ENGINE
SUCTION PORT
DISCHARGE PORT
PUMP
TOOLBOX
CARRYING HANDLE

Figure 1-5. 50-gpm pumping assembly.

a rectangular aluminum box that can be used as a carrying case. The box has an oval inner compartment to hold the mounting base of the pump and engine assembly. An outer compartment holds the coiled lengths of hose, the drum-unloader suction stub, the ground rod, and the muffler. The dispensing nozzles are stored in mounting brackets on the underside of the box lids. The pump assembly must be bonded and grounded before operation (page 10-7). TM 10-4320-202-15 and TM 5-4320-237-15 contain information on the operation and maintenance of 50-gpm assemblies.

☐ **Pump.** The pump assembly is a self-priming, centrifugal gasoline pump. The pump is coupled to the engine by an intermediate adapter, and the pump impeller is mounted directly on an extension of the engine crankshaft. Pump suction and discharge ports have 1 1/2-inch, quick-coupling adapters with dust caps.

☐ **Engine.** The dispenser has a one-cylinder four-cycle, air-cooled gasoline engine.

☐ **Hose and fittings.** Two 25-foot sections of 1 1/2-inch, wire-reinforced suction hose and two 50-foot sections of 1 1/2-inch collapsible, synthetic rubber discharge hose come with the pumping assembly. Each section of suction hose is fitted with a 1 1/2-inch, female quick-coupling half on one end and a 1 1/2-inch, male quick-coupling half on the other.

944

The discharge hoses have 1 1/2-inch female, quick-coupling halves on both ends. All quick-coupling halves are fitted with dust caps or plugs.

■ **Use.** The 50-gpm portable pumping assembly is used to transfer fuel from one bulk storage tank to another and from storage tanks, tank cars, and tank vehicles to 55-gallon metal drums, 500-gallon collapsible drums, vehicles, and aircraft. When aircraft is refueled, the 50-gpm filter/separator must be used. With the suction stub attached to the suction hose, the pumping assembly can be used to empty 55-gallon drums. When equipped with a hose and fitting kit (page 1-7), it can be used to fill 5-gallon gasoline cans and refuel vehicles. The pumping assembly is also issued as part of the can and drum cleaning machine (page 4-1).

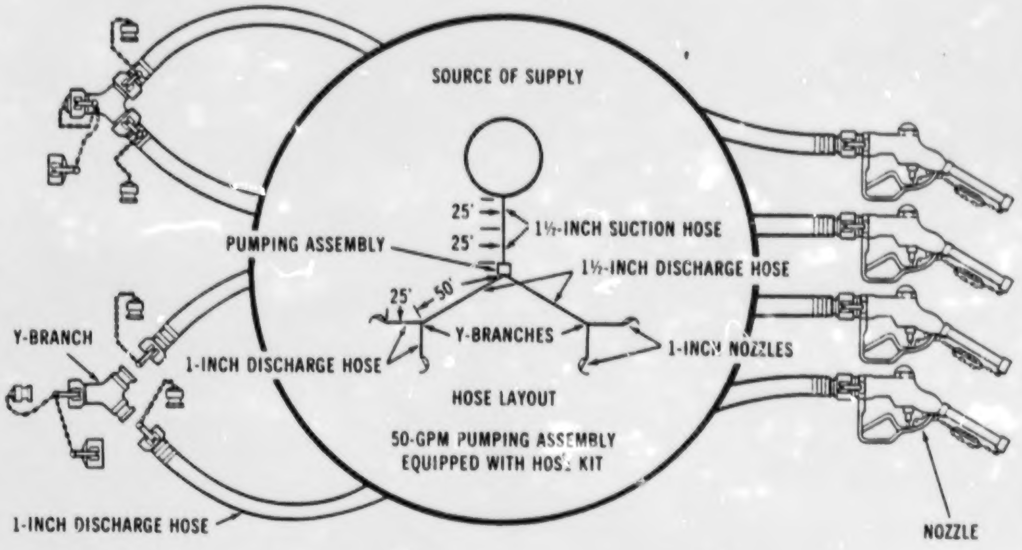

SOURCE OF SUPPLY
25'
25'
1½-INCH SUCTION HOSE
PUMPING ASSEMBLY
1½-INCH DISCHARGE HOSE
25'
50'
Y-BRANCHES
1-INCH NOZZLES
Y-BRANCH
1-INCH DISCHARGE HOSE
HOSE LAYOUT
50-GPM PUMPING ASSEMBLY EQUIPPED WITH HOSE KIT
1-INCH DISCHARGE HOSE
NOZZLE

Figure 1-6. Hose and fitting kit for 50-gpm pumping assembly.

Hose and Fitting Kit for 50-gpm Pumping Assembly

The hose and fitting kit (fig 1-6) is used to adapt the 50-gpm pumping assembly to fill 5-gallon gasoline cans and dispense directly into vehicle fuel tanks. The basic kit consists of two Y-branches, four 25-foot, collapsible discharge hoses, and four 1-inch dispensing nozzles. Dust caps and plugs are also supplied. When the kit is used with the pumping assembly, the two 1 1/2-inch nozzles are replaced by the two Y-branches.

968

Four 1-inch hoses, each fitted with a discharge nozzle, are then attached to the Y-branches. The kit comes in a carrying case. The items in the case are four 1-inch dust caps; two 1 1/2-inch dust plugs; four 1-inch dust plugs; four collapsible discharge hose assemblies (each 1 inch by 25 feet long with a male and female quick-coupling half); four 1-inch manual fuel and oil servicing nozzles; and two 1 1/2- by 1-inch Y branches.

100-gpm Gasoline-Engine-Driven Pumping Assembly for Bulk Transfer of Flammable Liquids

■ **Description.** The 100-gpm pumping assembly (fig 1-7) consists of a gasoline-engine-driven pump mounted on a frame, a rigid-wall suction hose, two discharge hoses, and two manually operated hose nozzles. The unit must be grounded before operation. TM 5-4320-259-12 gives information on the operation and maintenance of the 100-gpm pumping assembly. Another 100-gpm pumping assembly, used as a component of the forward area refueling equipment (FARE) system, is discussed on page 5-1.

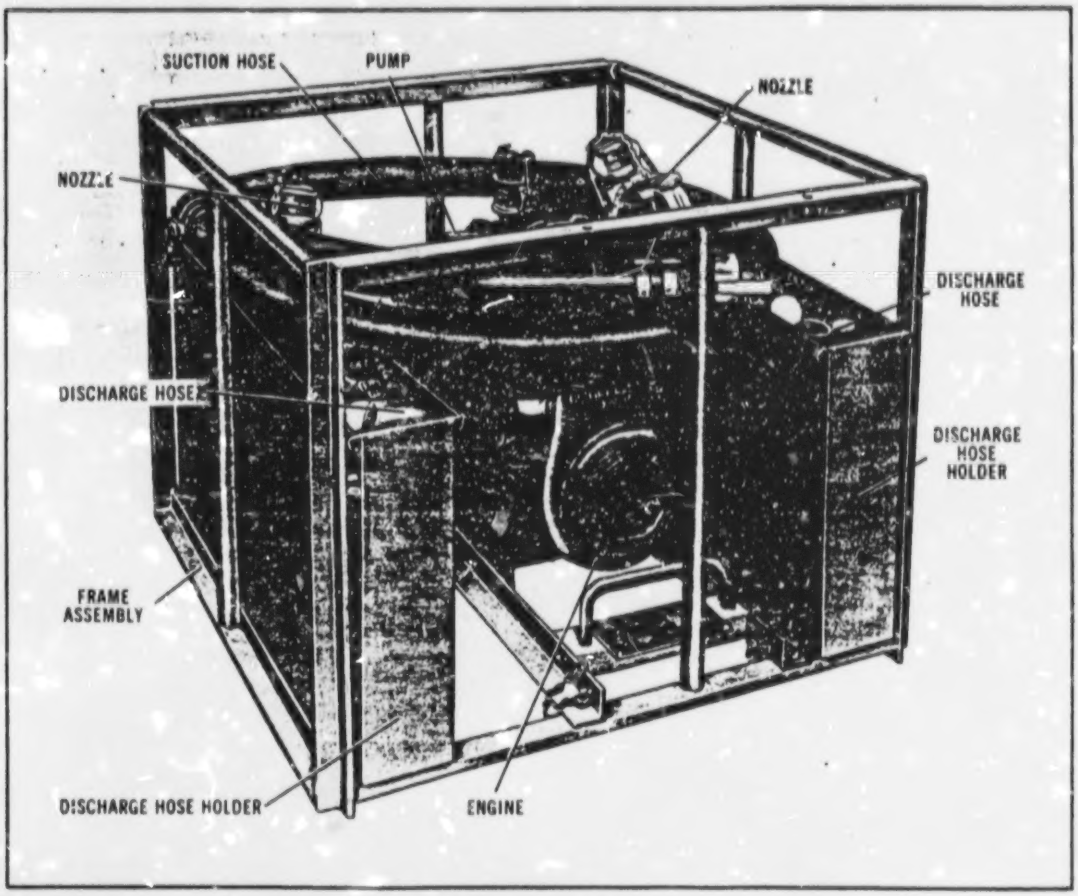
☐ **Pump.** The centrifugal pump is coupled directly to the engine. The pump impeller is mounted on the threaded end of the engine crankshaft. After it is primed the first time, the pump is self-priming. The pump has a 1 1/2-inch suction port, and it discharges through a pipe cross. The two side ports of the pipe cross are used for hose connections while the upper port is used for priming. All ports on the pump are fitted with caps to keep out dirt when the pump is not in use.

☐ **Engine.** The dispenser is an air-cooled, one-cylinder, gasoline-driven, four-stroke-cycle engine. It develops 2 1/2-horsepower at 3,600 revolutions per minute (rpm). Its speed is controlled by a mechanical-flyball governor which controls the opening and closing of the carburetor throttle. The engine is splash lubricated.

☐ **Hoses and nozzles.** The suction and discharge hoses have quick-disconnect fittings so that they can be easily attached to the related ports. The 10-foot section of suction hose is stored on top of the pumping assembly. The two 25-foot sections of discharge hose are stored in containers mounted on each side of the pump. Two manually operated nozzles to control the flow of liquid are attached to the ends of the discharge hoses. The nozzles have quick-disconnect connectors.

■ **Use.** The 100-gpm pumping assembly is used to transfer fuel from storage tanks, tank cars, and tank vehicles to 5-gallon cans, 55-gallon drums, and 500-gallon collapsible drums. It can also be used to refuel vehicles and aircraft. When an aircraft is refueled, the 100-gpm filter/separator must be used.

Figure 1-7. 100-gpm pumping assembly.


SUCTION HOSE
PUMP
NOZZLE
NOZZLE
DISCHARGE HOSE
DISCHARGE HOSE
DISCHARGE HOSE HOLDER
FRAME ASSEMBLY
DISCHARGE HOSE HOLDER
ENGINE

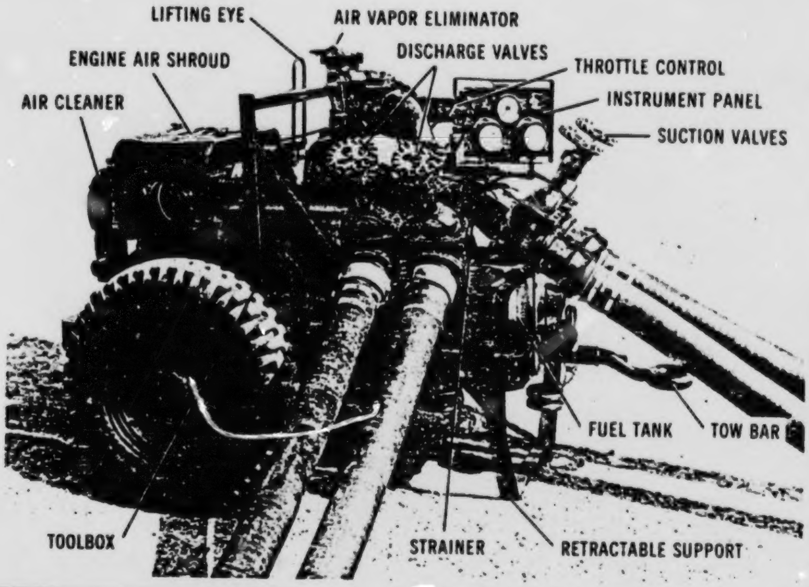

LIFTING EYE
AIR VAPOR ELIMINATOR
ENGINE AIR SHROUD
DISCHARGE VALVES
THROTTLE CONTROL
AIR CLEANER
INSTRUMENT PANEL
SUCTION VALVES
FUEL TANK
TOW BAR
TOOLBOX
STRAINER
RETRACTABLE SUPPORT

Figure 1-8.
350-gpm
pumping assembly.

350-gpm Pumping Assembly for Bulk Transfer of Flammable Liquids

■ **Description.** The 350-gpm pumping assembly (fig 1-8) is mounted on a two-wheel, pneumatic-tired trailer that has a towbar which can be attached to a jeep or a 1/4-ton truck. However, the assembly should be towed for only short moves in the immediate area of operation. If the pumping assembly has to be moved for a longer distance, it should be loaded on a 2 1/2-ton truck or a flatbed trailer. The assembly must be braced, blocked, and tied down before it is moved on these vehicles. When the pumping assembly is operated, the ground rod and cable must be used because the unit does not come in contact with the ground. TM's 5-4320-218-15 and 5-4320-272-34 have more information on the 350-gpm pumping assembly.

☐ **Pump.** The self-priming centrifugal pump is rated at 350-gpm at about 80 pounds per square inch (psi) (275 feet of head, 0.725 specific gravity (sp gr)). It has double inlets and outlets, and gate valves control all ports.

☐ **Engine.** The pump is driven by a four-cylinder, air-cooled, gasoline engine. The starter switch is located on the instrument panel. Gages on the panel show engine vacuum, oil pressure, revolutions per minute, pump suction and discharge pressures, and hours of operation.

■ **Use.** The 350-gpm pumping assembly is used mainly with the fuel system supply point (page 6-2). It moves fuel from the source of supply to the tanks and from the tanks to the dispensing equipment. The pump may also be used with any of the collapsible tanks now used by the Army and with the 4-inch hoseline outfit (assault hoseline).

CHAPTER 3

STORAGE CONTAINERS

CONTAINERS AND HANDLING EQUIPMENT FOR PACKAGED PETROLEUM PRODUCTS

Packaged Petroleum Products and Fuels

Packaged petroleum products are not the same as packaged petroleum fuels. Both are described below.

- **Products.** Packaged petroleum products (class III A3 and W6) include lubricants, greases, hydraulic fluids, and other specialty products that have been packaged at the procurement source. They are received directly from the vendor or issued through general supply depots or supply points following Military Standard Requisitioning and Issue Procedures (MILSTRIP).

- **Fuels.** Packaged petroleum fuels include fuel in containers of 500 gallons or less. The containers used most often are 5-gallon cans, 55-gallon drums, and 500-gallon collapsible drums. Fuels are usually issued in bulk. The need to transfer bulk petroleum fuels to packaged containers depends on such operational factors as the quantities required for daily operations, the capabilities of the units to receive and store fuels, the existence of a bulk distribution system, and the tactical situation.

5-Gallon Gasoline Can

- **Description.** The 5-gallon gasoline can (fig 3-1) is made of 20-gage sheet steel. The welded body is clinched to the bottom chime by a double seam. The head, welded to the top of the body, is fitted with three carrying handles and a 2-inch threaded flange with closure assembly. A vent tube is welded to the underside of the head and connected to a small vent hole in the flange. The vent makes the product flow freely when it is poured from the can. The can is closed by a threaded plug which screws into the flange. The plug is attached to the can by a swivel wire, swivel-wire hasp, connector link, and cotter pin. It is fitted with a synthetic-rubber gasoline-resistant gasket. The plug can be removed from the flange, and a flexible spout (inset, fig 3-1) can be put in its place to help pour product from the can. A cap and screen can be screwed into the end of the spout to screen out gross sediment.

- **Use.** The 5-gallon can is used to issue small quantities of gasoline to using units. It is especially useful when conditions are such that the container must be carried by hand.

CHAPTER 3

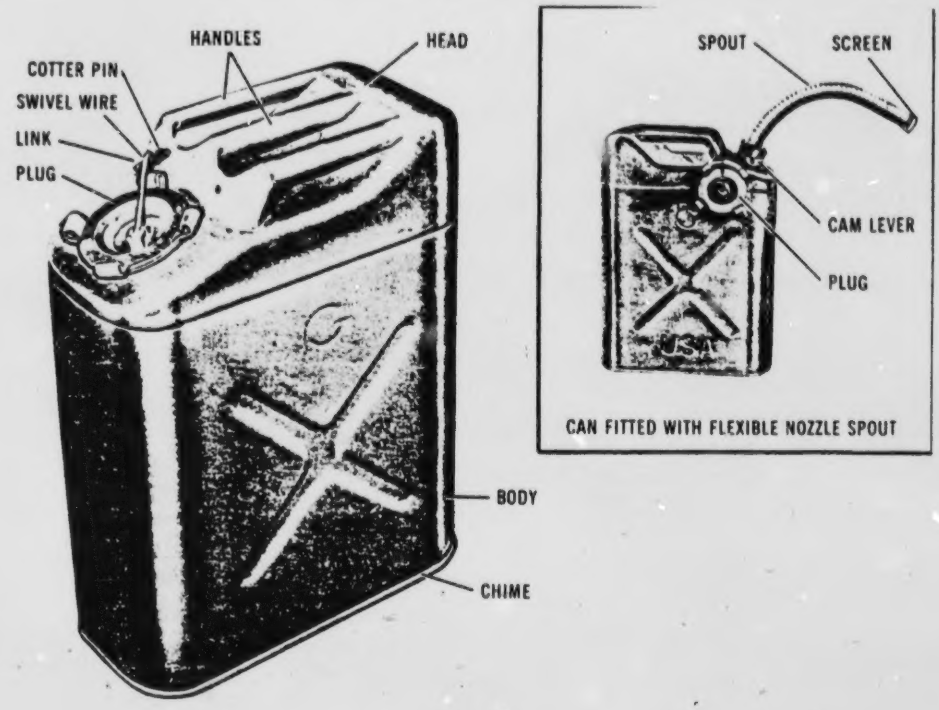
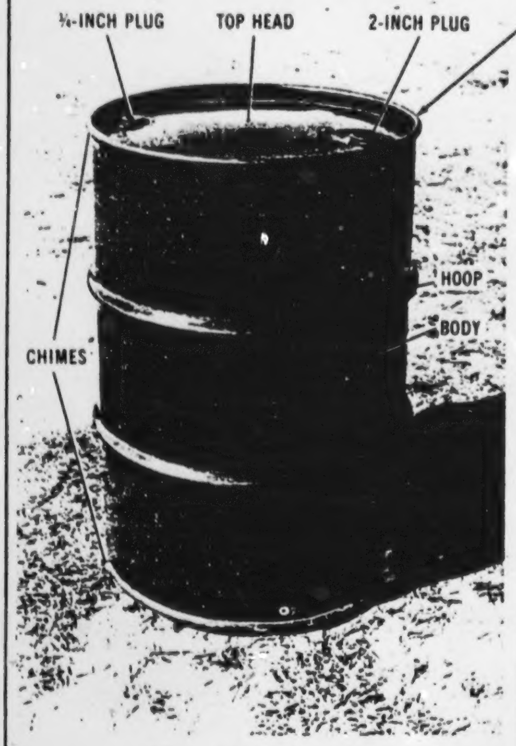

HANDLES
HEAD
COTTER PIN
SWIVEL WIRE
LINK
PLUG
BODY
CHIME
SPOUT
SCREEN
CAM LEVER
PLUG
CAN FITTED WITH FLEXIBLE NOZZLE SPOUT

Figure 3-1. 5-gallon gasoline can.

55-Gallon Steel Drum

■ **Description.** The 55-gallon drum (fig 3-2) is made of either 16- or 18-gage hot-rolled sheet steel. It has rolling hoops with an enameled exterior finish. The drumheads are held to the cylindrical body by double-seamed chimes. Chimes on the 16-gage drum are reinforced by a strip of sheet steel (inset, fig 3-2). Two flanged closures, a 2-inch plug and a 3/4-inch plug (vent), are mounted in the top head of each drum. The 16-gage drum is more durable than the 18-gage drum and can be reused. The 18-gage drum is mainly a one-time shipper. Product can be dispensed from the drum by a hand-driven pump mounted in the 2-inch closure. A drum-unloader suction stub can be connected to the suction hose of a power-driven pumping assembly to empty the drum. When the drum is in a horizontal position, a drum faucet can be installed in the 3/4-inch closure to draw off small quantities of product. The 55-gallon drum has an authorized capacity of 54 gallons for fuels


¼-INCH PLUG
TOP HEAD
2-INCH PLUG
HOOP
BODY
CHIMES

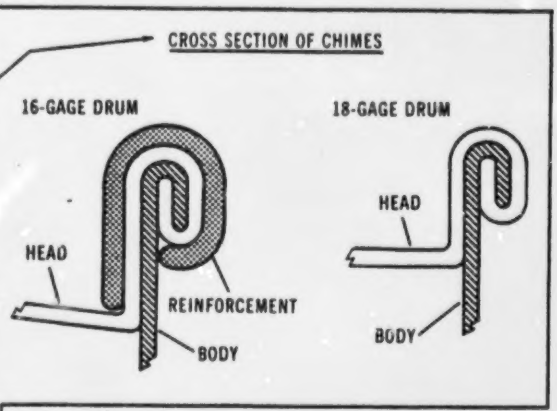

CROSS SECTION OF CHIMES
16-GAGE DRUM
18-GAGE DRUM
HEAD
REINFORCEMENT
BODY
HEAD
BODY

Figure 3-2. 55-gallon drum.

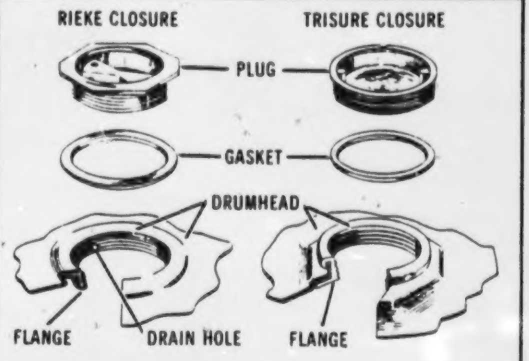

RIEKE CLOSURE
TRISURE CLOSURE
PLUG
GASKET
DRUMHEAD
FLANGE
DRAIN HOLE
FLANGE

Figure 3-3. Closures of 55-gallon drum.

with flashpoints lower than 80° F and 55 gallons for fuels with flashpoints higher than 80° F. The closure consists of a threaded flange pressed into the drumhead, a male threaded plug, and a synthetic-rubber gasket. Both closures on any one drum should be of the same type, either Rieke or Trisure. A Rieke plug can be screwed into a Trisure flange, or vice versa, but it will usually leak. The two designs are not the same, and part of one can't be used with part of the other. The plug and gasket must match the flange (fig 3-3).

■ **Use.** The 55-gallon drum is used to issue fuel and lubricating oil to using units. It can be used in most situations. However, it can't be used when the terrain or tactical situation makes it necessary to deliver fuel in containers that can be hand-carried. ⊙

CHAPTER 3

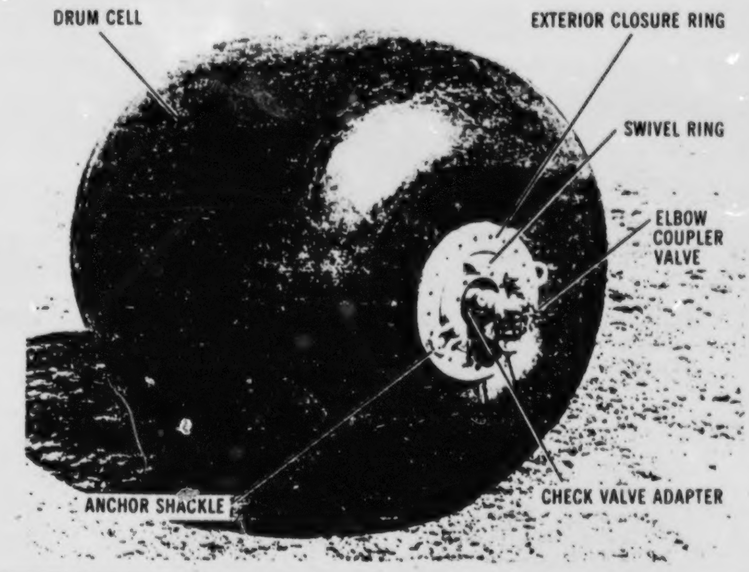


Figure 3-4. Filled 500-gallon collapsible drum.

500-Gallon Liquid Fuel Collapsible Fabric Drum

■ **Description.** The two models of the 500-gallon collapsible drum now in use are the long drum (model 4C-135-03562) and the shortie drum (model 5-14-191-1). The two drums are described below and more information is in TM 10-8110-201-14.

☐ **Long 500-gallon collapsible drum, model 4C-135-03562.** The long 500-gallon collapsible drum is a nonvented container made of fabric impregnated with fuel-resistant, synthetic rubber. The drum has a closure plate on each end. The plates are tied together inside the drum with support cables so that they do not expand in length when the drum is filled. Each closure plate has a swivel ring with two anchor shackles to provide points where a lifting sling or towing and lifting yoke can be attached. It can also be used to tie the drum to a vehicle. The drum is filled and emptied through an elbow coupler valve and check valve adapter in the front closure plate. The elbow coupler valve that comes with the drum is attached to the check valve adapter. When the pressure control (below) is used for the filling operation, the discharge hose of the control is attached to the elbow coupler valve; when the pressure control is not used, the hose of the pumping assembly is attached direct to the elbow coupler valve. A filled drum is about 6 feet 8 inches long and 3 feet 10 inches in diameter. It is designed for a regular working pressure of 4 to 5 psi and a top working pressure of 45 psi. The collapsed drum can be folded so that it can be moved by trucks. Repair kits for

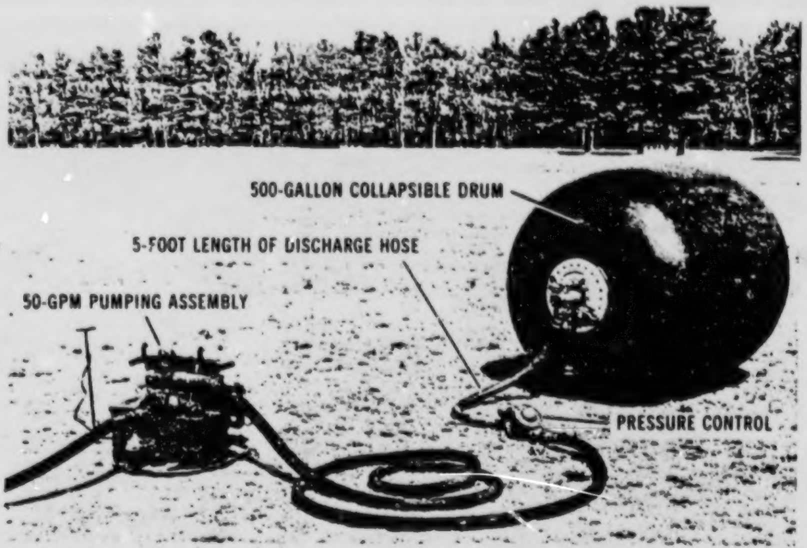


Figure 3-5. Pressure control connected between a 50-gpm pumping assembly and a 500-gallon collapsible drum for a filling operation.

500-gallon collapsible drums (below) can be used for temporary repair.

☐ **Shortie 500-gallon collapsible drum, model 5-14-191-1.** The shortie drum (fig 3-4) is similar to the long drum. Both have the same capacity. They can be towed and handled in the same way when filled and folded in the same way when empty. However, the two models differ in size. When filled, the shortie drum is about 5 feet 2 inches long and 4 feet 5 inches in diameter.

☐ **Pressure control.** The pressure control is used to keep from pumping too much fuel into the nonvented collapsible drum and possibly rupturing it. It is used between the pumping assembly discharge line and the drum. The pressure control stops the flow of product when the pressure inside the drum reaches 5 psi. A recycling valve marked STOP can be used to stop the flow manually. A recycling valve marked FILL can be used to restart the flow. Figure 3-5 shows the pressure control connected for filling a drum.

☐ **Emergency repair kit.** The emergency repair kit (fig 3-6) is used for temporary repairs only. In other words, it contains items to stop leaks until the operator can empty the drum. There are two parts to the repair kit; types I and II. Type I is used for holes no larger than 3/8 inch. Type II is for holes larger than 3/8 inch and tears up to 7 inches. The installation of tapered sealing plugs and sealing clamps is discussed on page 14-13. Repaired drums should not be towed,

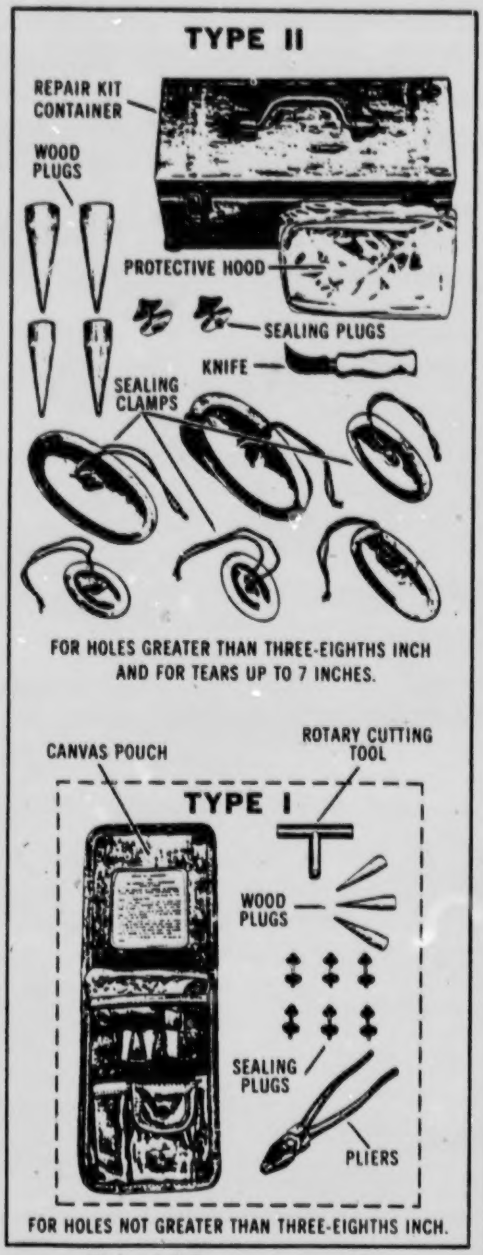

TYPE II
REPAIR KIT CONTAINER
WOOD PLUGS
PROTECTIVE HOOD
SEALING PLUGS
KNIFE
SEALING CLAMPS
FOR HOLES GREATER THAN THREE-EIGHTHS INCH AND FOR TEARS UP TO 7 INCHES.
CANVAS POUCH
ROTARY CUTTING TOOL
TYPE I
WOOD PLUGS
SEALING PLUGS
PLIERS
FOR HOLES NOT GREATER THAN THREE-EIGHTHS INCH.

Figure 3-6. Emergency repair kit.

lifted, or moved until they have been emptied. They should then be taken at once to the maintenance facility for permanent repair.

■ **Use.** The 500-gallon collapsible drum is used to supply fuel to isolated ground troops. The drums can be used for storage. Filled drums can be towed or rolled by hand a short distance to a dispensing area, used with a tiedown kit to convert cargo trucks into fuel carriers, and dropped from or delivered by aircraft.

☐ **Towed by truck.** A filled drum can be towed a short distance to a dispensing area by a cargo truck (fig 3-7). A towing and lifting yoke must be used, and the drum must not be towed over sharp objects or rough ground.

☐ **Carried by truck.** Collapsible drums can be carried from a filling site to a dispensing area in 2 1/2- or 5-ton cargo trucks (fig 3-8) or on a stake or platform trailer. Tiedown kits are used to hold the drums during transport.

☐ **Carried by aircraft.** Filled drums can be dropped by parachute, delivered by aircraft sling load (fig 3-9), or transported as air cargo. The drums must not be free-fall airdropped. Rigging, loading, and dropping procedures in TM 10-500-64 and TM 55-450-11 must be followed.

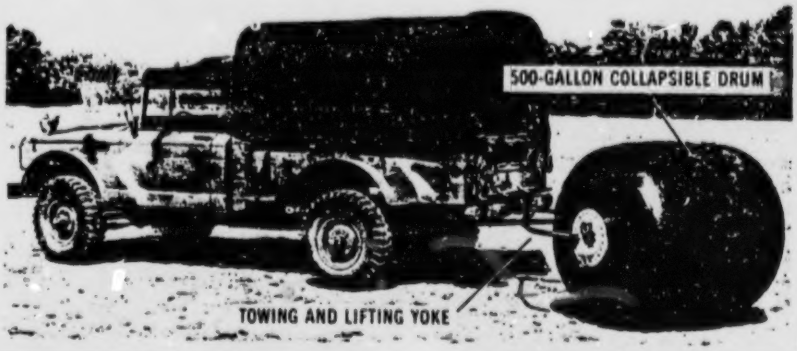

500-GALLON COLLAPSIBLE DRUM
TOWING AND LIFTING YOKE

Figure 3-7.

Filled 500-gallon drum being towed by cargo vehicle.

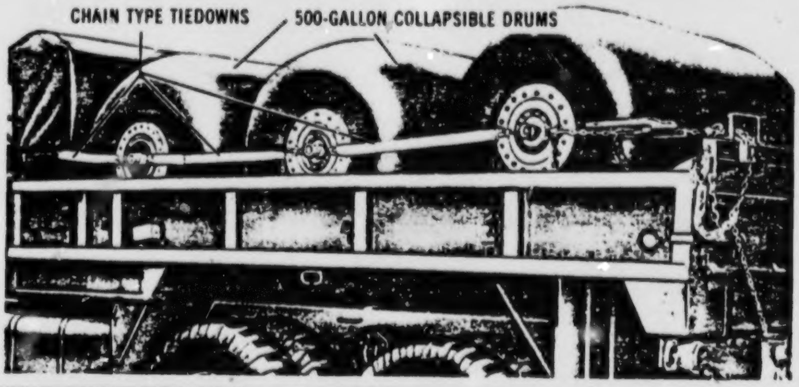

CHAIN TYPE TIEDOWNS
500-GALLON COLLAPSIBLE DRUMS

Figure 3-8.

Filled 500-gallon drums loaded on a cargo truck and held with a tiedown kit.

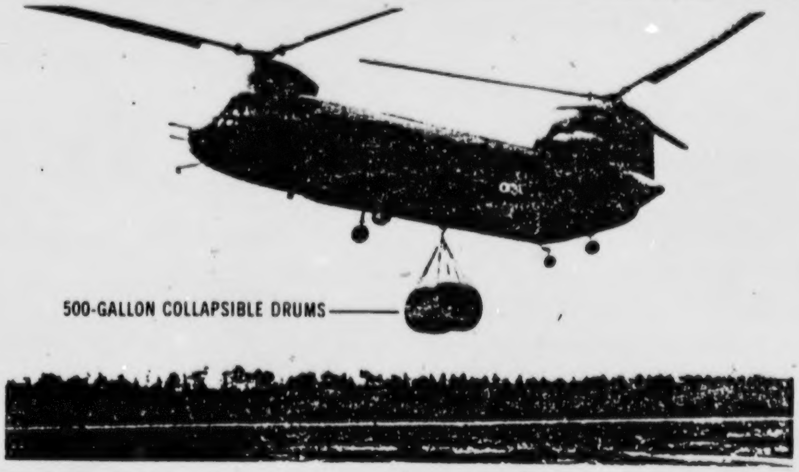

500-GALLON COLLAPSIBLE DRUMS

Figure 3-9.

Helicopter carrying filled 500-gallon drums.

CHAPTER 3

Handling Equipment

Items of equipment used to handle packaged petroleum containers are discussed below. Appendix A has publications that give instructions for use of the equipment. Precautions must be taken to avoid sparks when using this equipment. All internal combustion engines must be equipped with spark arresters. If the item of equipment is electric-powered it must be equipped with explosionproof wires and motors.

■ **Forklift Trucks.** Forklift trucks can lift, stack, and carry containers within the storage area, and they can handle heavy or palletized containers.

■ **Drum-Handling Attachments.** Drum-handling attachments are used with forklift trucks to lift and carry 55-gallon drums. The two types of attachments are the fork type (fig 3-10) and the chime-ring hook type (fig 3-11). The fork attachment is used when the trucks are working on level or smooth ground. This attachment fits on the upright of a forklift truck and can handle three filled drums. The chime-ring hook attachment is used when trucks are on rough ground. This attachment also fits on the upright of a forklift truck. It can handle only two filled drums.

■ **A-Frames.** A-frames and winches are mounted on the front of trucks and are used to lift and carry containers. Chime hooks are generally used with A-frames and are very useful in moving two or three 55-gallon drums at a time.

■ **Conveyors.** Wheel or roller type conveyors help move cans and drums within a storage area. They can be used on a level or an inclined plane. Power-driven conveyors are sometimes used to load, unload, and stack cans and drums.

■ **Skids.** Skids, made of long wooden planks or other suitable material, aid in loading,

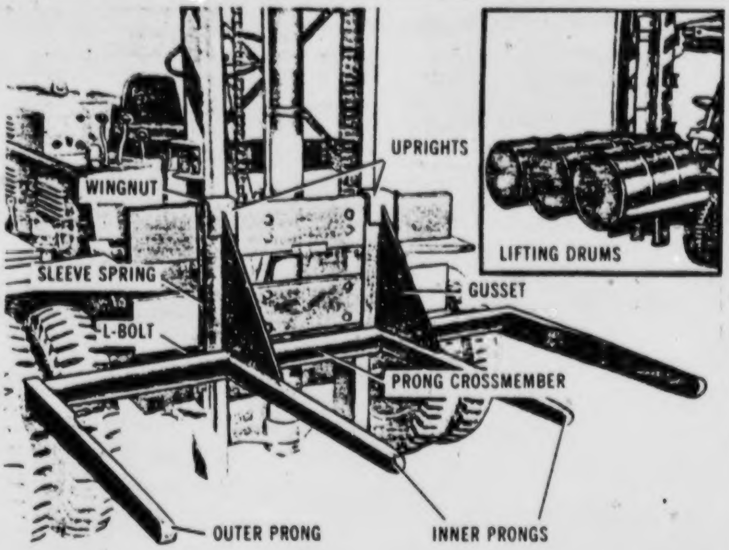


Figure 3-10. Fork type drum-handling attachment.

unloading, and stacking petroleum containers.

- **Cranes.** Cranes (fig 3-12) of various designs and capacities are often used to handle packaged products and fuels at large storage areas. A drum-handling sling that can handle six filled drums at a time can be used with the cranes.

- **Empty-Drum Track.** The empty-drum track is made of aluminum or other suitable material. It's built in sections that hook together. The track is used to roll empty drums to and from storage stacks.

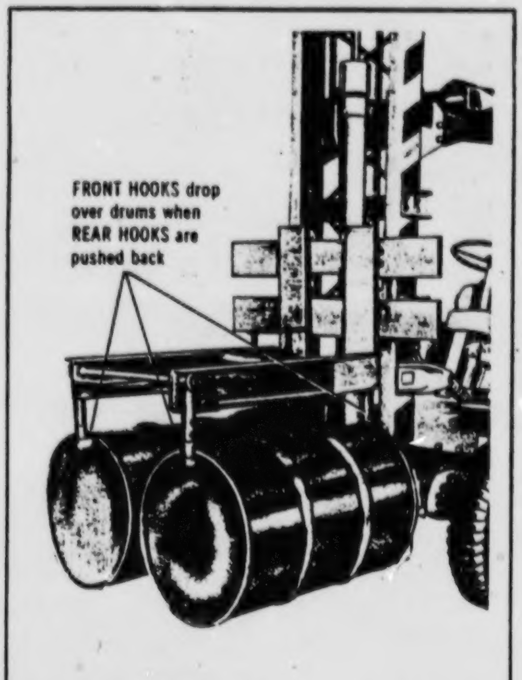

FRONT HOOKS drop over drums when REAR HOOKS are pushed back

Figure 3-11. Chime-ring hook type drum-handling attachment.

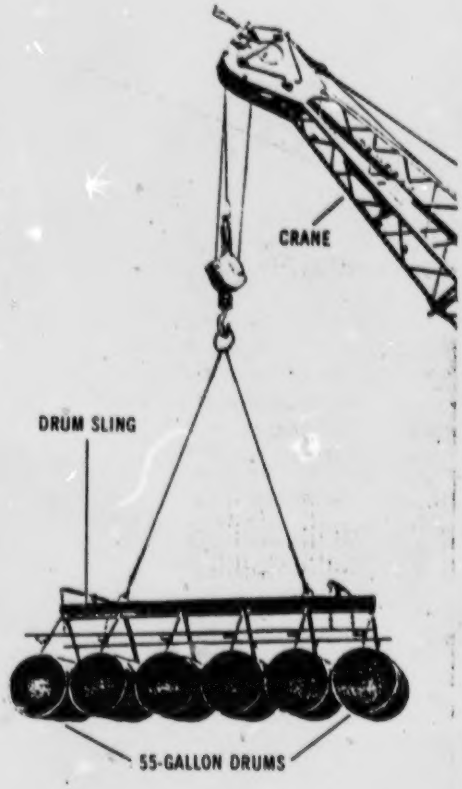

CRANE
DRUM SLING
55-GALLON DRUMS

Figure 3-12. Crane with drum-handling sling.

957

CHAPTER 3

BULK PETROLEUM CONTAINERS

Introduction

Bulk petroleum products include those petroleum products transported in pipelines, tankers, tank cars, tank vehicles, and other bulk carriers. Containers discussed in this section are used to store and deliver bulk petroleum products in quantities over 500 gallons.

600-GALLON METAL TANK WITH SKIDS

The 600-gallon, metal, skid-mounted tank (page 7-2) is a part of the tank unit (page 7-1) and the tank and pump unit (page 7-2) used to transport bulk petroleum fuel on trailers and cargo trucks. The tank can also be removed from the trailer and cargo truck and used for aboveground storage of fuel. Hand-operated pumps (page 1-2 and 1-3) can then be used to pump the fuel. The tank is issued as a separate item if there is a need and an authorization for it.

3,000-Gallon Collapsible Fabric Tank

■ **Description.** The 3,000-gallon collapsible fabric tank is made of single-ply elastomeric-coated nylon. It has four carrying handles, a filler/discharge assembly, and a vent fitting assembly. The tank has a hose and gate valve assembly and emergency repair items (page 3-14). When filled, the tank is about 12 feet 6 inches square and 4 feet high.

☐ **Filler/Discharge Assembly.** The filler/discharge assembly (fig 3-13) is located on top of the tank. It consists of an access door fitting, a 4-inch suction stub, an oval closure plate, a 4-inch flanged adapter coupled to a 4-inch elbow fitting, and a 4-inch dust cap.

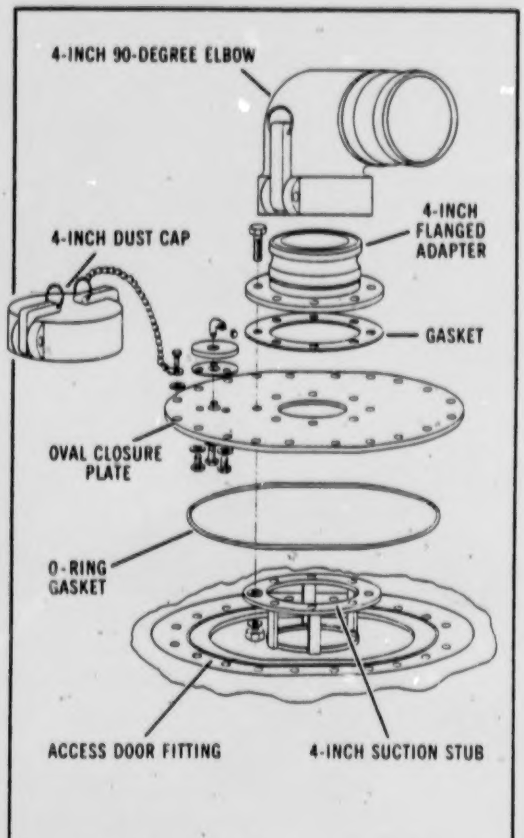


Figure 3-13. Filler/discharge assembly.

981

☐ **Vent fitting assembly.** The vent fitting assembly (fig 3-14) is located on top of the tank near the filler/discharge assembly. It consists of a vent flange attachment, a 2-inch quick-disconnect male coupling half connected to a 2-inch quick-disconnect female coupling half, a 2-inch dust cap, a 2-inch vent pipe, a flame arrester, and a pressure-relief cap with gasket. The pressure-relief cap of the vent assembly opens automatically when the vent assembly is subjected to an internal pressure of 3 inches of water.

☐ **Hose and valve assembly.** The 3,000-gallon collapsible tank comes with a hose and valve assembly to help transfer the product, because this tank is issued as a separate item and not as part of a system. The assembly consists of a 4- to 3-inch reducer, a 3-inch wire-reinforced hose assembly (4 feet long), and a 3-inch gate valve. The 4-inch female of the reducer is connected to the 4-inch elbow fitting of the filler/discharge assembly on the tank. The other end of the reducer is a 3-inch male. It is connected to the 3-inch hose assembly which in turn is coupled to the 3-inch gate valve.

■ **Use.** The 3,000-gallon collapsible tank is used for temporary ground storage of liquid fuels. With the hose and valve assembly attached, the tank can receive and dispense bulk petroleum fuels. The tank is generally used in small bulk petroleum operations where the fuel system supply point (page 6-2) and the 50,000-gallon collapsible tank (page 3-13) are impractical. ⊙

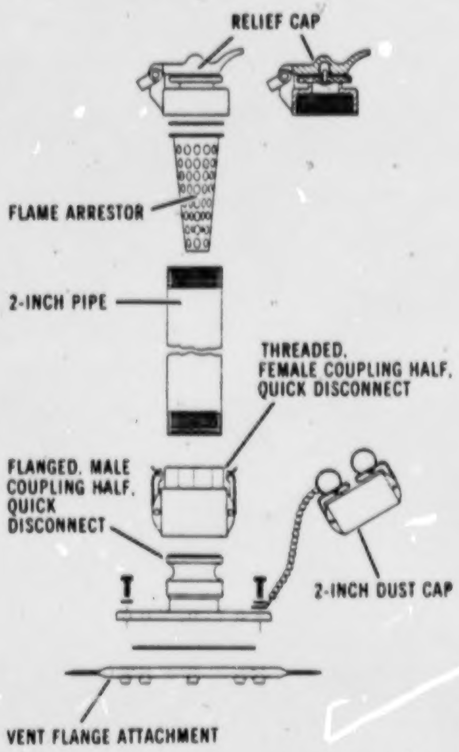

RELIEF CAP
FLAME ARRESTOR
2-INCH PIPE
THREADED, FEMALE COUPLING HALF, QUICK DISCONNECT
FLANGED, MALE COUPLING HALF, QUICK DISCONNECT
2-INCH DUST CAP
VENT FLANGE ATTACHMENT

Figure 3-14. Vent fitting assembly (same for all collapsible tanks).

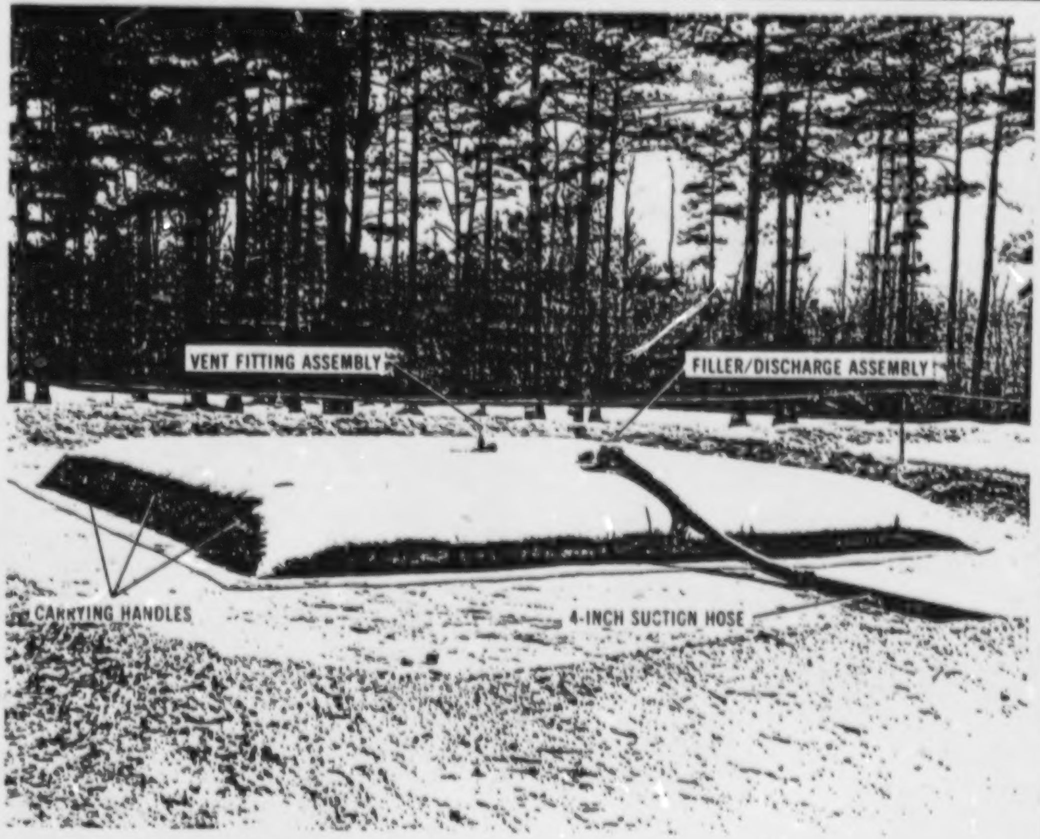


Figure 3-15. 10,000-gallon collapsible tank.

10,000-Gallon Collapsible Fabric Tank

■ **Description.** The 10,000-gallon collapsible fabric tank (fig 3-15) looks a lot like the 3,000-gallon collapsible tank. It is made of single ply elastomeric-coated nylon. It has six carrying handles, a filler/discharge assembly, a vent fitting assembly, and a drain fitting assembly. The tank also has emergency repair items (page 3-14). When filled, the tank is about 20 feet 6 inches square and 4 feet high.

☐ **Filler/discharge assembly.** The filler/discharge assembly (fig 3-13) is on top of the tank. It is similar to that of the 3,000-gallon collapsible tank. Page 3-10 lists the parts of the filler/discharge assembly.

☐ **Vent fitting assembly.** The vent fitting assembly (fig 3-14) is located on top of the tank near the filter/discharge assembly. It is just like the one on the 3,000-gallon collapsible tank. Page 3-11 lists the parts of the assembly. The pressure-relief cap of the vent assembly on the 10,000-gallon collapsible tank opens automatically when the vent assembly is subjected to an internal pressure of 3 inches of water.

☐ **Drain fitting assembly.** The drain fitting assembly is used to remove water. It is located on the bottom of the tank and it consists of a vent flange attachment, a drain fitting, and a plug and chain. The assembly has a 6-foot length of 1/2-inch nonwire-reinforced hose assembly with male fittings on both ends and a 1/2-inch rising-stem gate valve. These items are attached to the drain fitting assembly to help drain water from the tank.

■ **Use.** The 10,000-gallon collapsible storage tank is used to store petroleum products. It is usually a part of the fuel system supply point (page 6-2), but it is also issued as a single item for additional bulk storage. ②

50,000-Gallon Collapsible Fabric Tank

■ **Description.** The 50,000-gallon collapsible tank is made of single ply elastomeric-coated nylon. It has 18 carrying handles, two filler/discharge assemblies with access doors, a vent fitting assembly, and a drain fitting assembly. The tank also has a hose and valve assembly and emergency repair items (page 3-14). When filled, the tank is about 65 feet long, 25 feet wide, and 6 feet high.

☐ **Filler/discharge assemblies.** The two filler/discharge assemblies (fig 3-13) are located on top of the tank. One is located at each end, so the tank can receive and discharge fuel from both sides. Page 3-10 lists the components.

☐ **Vent fitting assembly.** The vent fitting assembly (fig 3-14) is centrally positioned on top of the tank. It is the same as that on the 3,000-gallon collapsible tank. Page 3-11 lists the components. The pressure-relief cap of the vent assembly opens automatically when it is subjected to an internal pressure of 3 inches of water.

☐ **Drain fitting assembly.** The drain fitting assembly used to remove water is located on the bottom of the tank. The components of the assembly are identical to those on the 10,000-gallon collapsible tank. Page 3-13 lists these components. The assembly has an 8-foot length of 1/2-inch nonwire-reinforced hose assembly with male fittings on both ends and a 1/2-inch rising-stem gate valve. These are attached to the drain fitting assembly to help drain water from the tank.

☐ **Hose and valve assembly.** The 50,000-gallon collapsible tank is issued as a single item of equipment and not as part of a system, so it has a hose and valve assembly to help transfer product. The assembly consists of a 4-inch, wire-reinforced hose assembly (10 feet long) and a 4-inch gate valve. The female end of the 4-inch hose assembly is connected to the 4-inch elbow fitting of the filler/discharge assembly on the tank. The male end of the hose assembly is coupled to the 4-inch gate valve.

■ **Use.** The 50,000-gallon collapsible tank is used to store liquid fuels in large bulk petroleum operations. With the hose and valve assembly attached, the tank can receive and dispense fuels at temporary beachheads and at intermediate points along trunk hoseline and pipeline systems. The tank may also be used for temporary storage at supply installations and airfields until permanent facilities can be built. The tanks are also used in tactical class III supply points to issue bulk petroleum to tank trucks and tank semitrailers. As part of the class III supply point, the tanks provide maximum flexibility in the handling of various fuels (mogas, diesel, and JP-4). For example, mogas may be placed in the fuel system supply point, while diesel and JP-4 may be placed in 50,000-gallon collapsible tanks (two tanks for each product). ⊙

Emergency Repair Items

Emergency repair items (fig 3-6) are issued with each collapsible tank. They include two 3-inch tapered wood plugs, two 5-inch tapered wood plugs, four 3-inch sealing clamps, two 5-inch sealing clamps, two 7 1/2-inch sealing clamps, and O-rings and gaskets. These items are to be used only for emergency or temporary repairs. A ruptured tank may be repaired in the field, but it should be carried to the general support maintenance facility as soon as possible for permanent repair. Page 14-13 has more on emergency tank repair. ⊙

962

CHAPTER 6

FUEL SYSTEM SUPPLY POINT

Introduction

The fuel system supply point is the Army's primary means of distributing and issuing bulk petroleum to combat forces under tactical conditions. This chapter briefly describes the fuel system and its major parts. Another description is in TB 5-4930-201. Chapters 12 and 14 of this manual contain information on site selection, layout, displacement, and operation.

Description

The fuel system supply point consists of two 350-gpm pumping assemblies; two 350-gpm filter/separators; six 10,000-gallon collapsible tanks; six bottom loading points for loading tank trucks and semitrailers; two 500-gallon collapsible drum-filling points; and six refueling points for filling vehicle fuel tanks, 5-gallon cans, and 55-gallon drums. The components of the fuel system are connected by about 2,400 feet of hose with 11 types of fittings. Figure 6-1 shows a typical layout. Table 6-1 lists the components.

■ **Receiving Manifold.** The receiving manifold consists of a wye and tee assembly (reducing from 4 to 3 inches), lengths of 3-inch suction hose, and 3-inch gate valves (fig 6-1). With this manifold, the fuel system can receive product from more than one transporter at a time. It also provides a way to switch from one supply source to another. Grounding equipment must be used whenever fuel is received through the manifold, because contact between the manifold and the ground is not perfect.

■ **Pumping Assemblies, Filter/Separators, and Collapsible Tanks.**

☐ **350-gpm pumping assembly.** The 350-gpm pumping assemblies used as components of the fuel system supply point are discussed on page 1-10.

☐ **350-gpm filter/separator.** Two vertically mounted, 350-gpm filter/separators (page 2-6) are used with each fuel system to remove entrained water and solid contaminants from the fuel before it is pumped into vehicles or containers.

☐ **10,000-gallon collapsible tank and manifold.** Six 10,000-gallon collapsible tanks (page 3-12) come with the fuel system. One hoseline manifold assembly with two tee fittings and one assembly with one tee fitting is used with each tank assembly. The manifold (fig 6-2) has two rising-stem double-acting gate valves to control the flow of fuel into and out of the collapsible tank.

986

CHAPTER 6

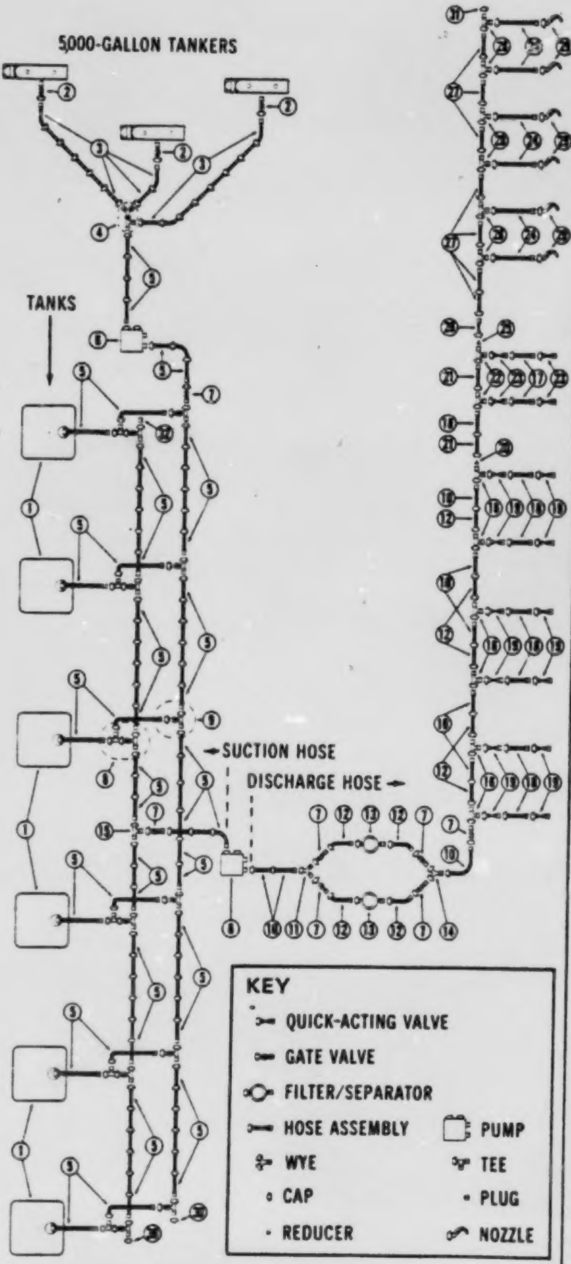


Figure 6-1. Typical layout of the fuel system supply point.

93

Table 6-1. Components of the fuel system

ITEM	DESCRIPTION	NO. REQD.
1	Tank, 10,000 gallon, collapsible, petroleum	6
2	Valve 3" gate, flanged with M and F CL	3
3	Hose, suction, 3" X 12' M CL one end, F CL other	16
4	Wye and tee assembly, flanged, M CL 3" and 4"	1
5	Hose, suction, 4" X 10' M CL one end, F CL other	83*
6	Pump, 350-gpm, 4" with M and F CL	2
7	Valve, gate, 4", flanged, with M and F CL	25*
8	Manifold, with 2 tee fittings	*
9	Manifold with one tee fitting	*
10	Hose, discharge, 4" X 50', with M and F CL	8
11	Wye assembly, flanged, 4" with one F CL inlet, 2 M CL outlets	1
12	Hose, discharge, 4" X 25' M and F CL	9
13	Filter/separator, 350-gpm, 4" with M and F CL	2
14	Wye assembly, flanged, 4", with 2 F CL inlets and one M CL outlet	1
15	Tee assembly, flanged, 4" with 2 M CL and one F CL	1
16	Tee assembly, flanged, 4 X 3" with one 4" M CL, one 4" F CL and one 3" M CL	6
17	Hose, discharge, 1-1/2" X 25' M and F CL	5
18	Hose, discharge, 3" X 25' M and F CL	4
19	Valve, quick-acting, 3" M and F CL	12
20	Reducer, 4" F CL X 3" M CL	1
21	Hose, discharge, 3" X 50' M and F CL	2
22	Tee assembly, flanged, 3" X 1-1/2" with one 3" F CL, one 3" M CL, and one 1-1/2" M CL	5
23	Valve, quick-acting, 1-1/2" M and F CL	4
24	Hose, discharge 1" X 25' M and F CL	6
25	Reducer 3" F CL X 2" M CL	1
26	Valve, quick-acting, 2" M and F CL	1
27	Hose, discharge, 2" X 25' M and F CL	7
28	Tee, reducing 2", F CL X 2" M CL X 1" M CL	6
29	Nozzle, 1" with adapter	6
30	Dust cap 4" CL	2
31	Dust cap 2" CL	1
32	Dust plug 4" CL	1

The following abbreviations are used in this table:

CL - cam-locking couplings
M - male
F - female

NOTE:

*Each of the six storage tanks come with a manifold consisting of eight lengths of hose, one double tee, one single tee, and two 4" gate valves.

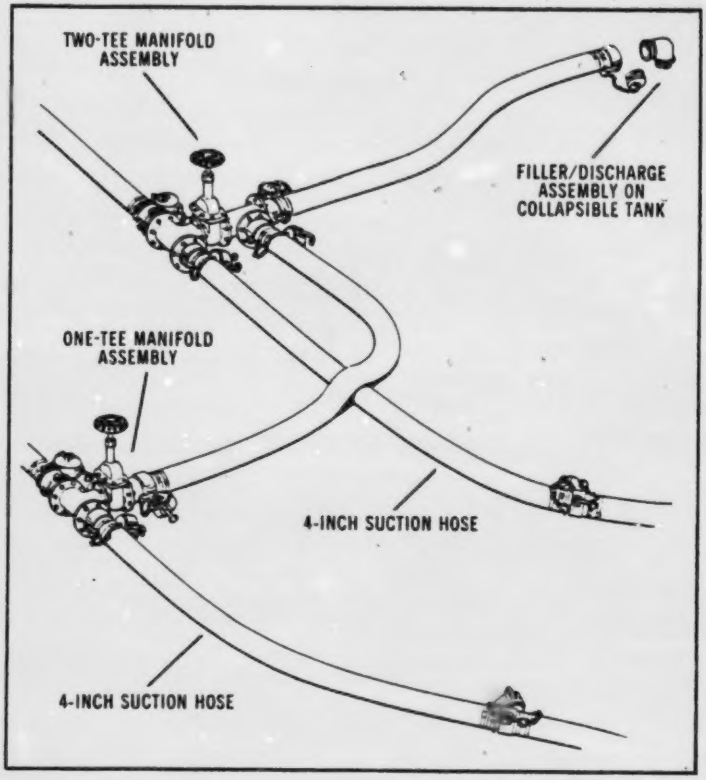

TWO-TEE MANIFOLD ASSEMBLY
FILLER/DISCHARGE ASSEMBLY ON COLLAPSIBLE TANK
ONE-TEE MANIFOLD ASSEMBLY
4-INCH SUCTION HOSE
4-INCH SUCTION HOSE

Figure 6-2.
Manifold and hose assemblies.

■ **Bottom Loading Points.** The fuel system has six 3-inch bottom loading points to load fuel into tank semitrailers. Each bottom loading point consists of a tee assembly (reducing from 4 inches to 3 inches) coupled to a 3-inch quick-acting valve followed by 25 feet of 3 inch discharge hose coupled to a 3-inch quick-acting valve (fig 6-1).

■ **500-Gallon Collapsible Drum Filling Points.** There are two 500-gallon collapsible drum filling points in the fuel system. Each point consists of a tee assembly (reducing from 3 inches to 1 1/2 inches) coupled to a 1 1/2-inch quick-acting valve followed by 25 feet of 1 1/2-inch discharge hose coupled to a 1 1/2-inch quick-acting valve (fig 6-1). The pressure control, not a component of the fuel system, is also used for the filling operation. The inlet of the pressure control is attached to the downstream end of the 1 1/2-inch discharge hose, and the 5-foot length of pressure-control discharge hose is connected from the control outlet to the drum elbow coupler valve (fig 6-1).

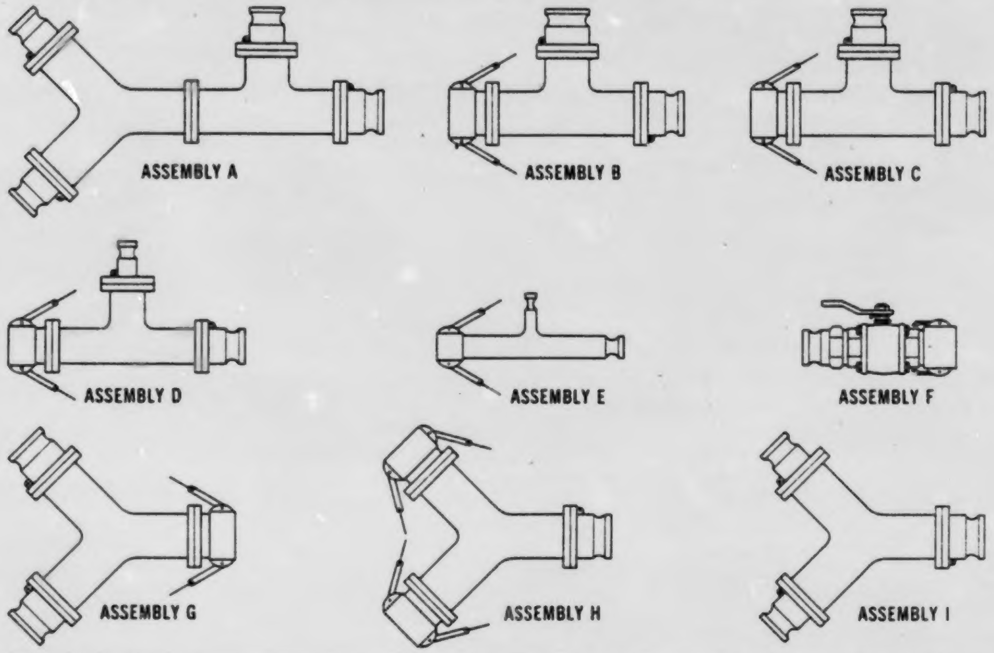
■ **5-Gallon Can and 55-Gallon Drum Filling and Vehicle Refueling Points.** There are six 5-gallon can and 55-gallon drum filling and vehicle refueling points in the fuel system. Each point consists of a tee assembly (reducing from 2 inches to 1 inch), followed by

965

25 feet of 1-inch discharge hose coupled to a 1-inch aluminum nozzle (fig 6-1).

■ Hoses, Fittings, Accessories, and Tools.

☐ **Suction and discharge hoses.** The two types of hose assemblies used in the fuel system are suction hose and discharge hose assemblies. Each hose assembly has a male coupling with dust cap on one end and a female coupling with dust plug on the other end. Figure 6-1 shows where the lengths of hoses are used. The dust caps and plugs must be used when the hose sections are not connected to the system.



Assembly A.	Flanged wye and tee assembly, three 4-inch adapter flange to 3-inch male, one 4-inch male.
Assembly B.	Tee assembly, two 4-inch male, one 4-inch female.
Assembly C.	Tee assembly, one 4-inch female, one 4-inch male, one 4-inch adapter flange to 3-inch male.
Assembly D.	Tee assembly, one 3-inch female, one 3-inch male, one 3-inch adapter flange to 1 1/2-inch male.
Assembly E.	Reducer tee, one 2-inch female, one 2-inch male, one 1-inch male.
Assembly F.	Quick-acting valve in these sizes: 3-inch cam-lock coupling and adapter size with 2-inch body; 2-inch cam-lock coupling and adapter with 2-inch body; 1 1/2-inch cam-lock coupling and adapter with 1 1/2-inch body.
Assembly G.	Wye assembly, two 4-inch male, one 4-inch female.
Assembly H.	Wye assembly, two 4-inch female, one 4-inch male.
Assembly I.	Wye assembly, one 4-inch male, two 4-inch adapter flange to 3-inch male.

Figure 6-3. Fitting assemblies in the fuel system supply point.

☐ **Fitting assemblies.** There are 11 types of fitting assemblies (fig 6-3) in the fuel system to connect hose sections, valves, and components. Dust caps and plugs must be kept on the assemblies when they are not in use. Figure 6-1 shows the location of each fitting assembly.

☐ **Accessories and tools.** Accessories and tools come with the fuel system so that it can be connected to different fuel transporters, other pumping assemblies, or pipelines. They can also be used to connect the components of the system in many combinations. The tools used to repair hose assemblies include a hoseclamp locking tool, buckles, and bandings. Accessories include a tank car-to-hose assembly adapter; a pipe clamp coupling; a pipe coupling for connecting the fuel system to a pipeline; reducers for connecting different size hoses; coupling halves (flanged and threaded) to make a number of connections; and gate valves and wye fittings.

Use

The fuel system is used at distribution points to provide storage facilities for transferring bulk fuel from one means of transport to another, and dispensing facilities for bulk reduction or delivery of fuel to using vehicles. The system can receive product from tank trucks, railway cars, pipelines, hoselines, and aircraft. It can also receive fuel from ocean tankers so it is capable of beachhead operations. The system can store 60,000 gallons of bulk petroleum. It can store even more if 10,000-gallon or 50,000-gallon collapsible tanks are added to the system. However, this expansion requires additional hoses, fittings, and valves. The system can be easily moved from one place to another, and it can be divided in half to handle two different types of fuels at two different locations (fig 6-4). The system can also be changed to a 10-point hot-refueling system for rotary aircraft.

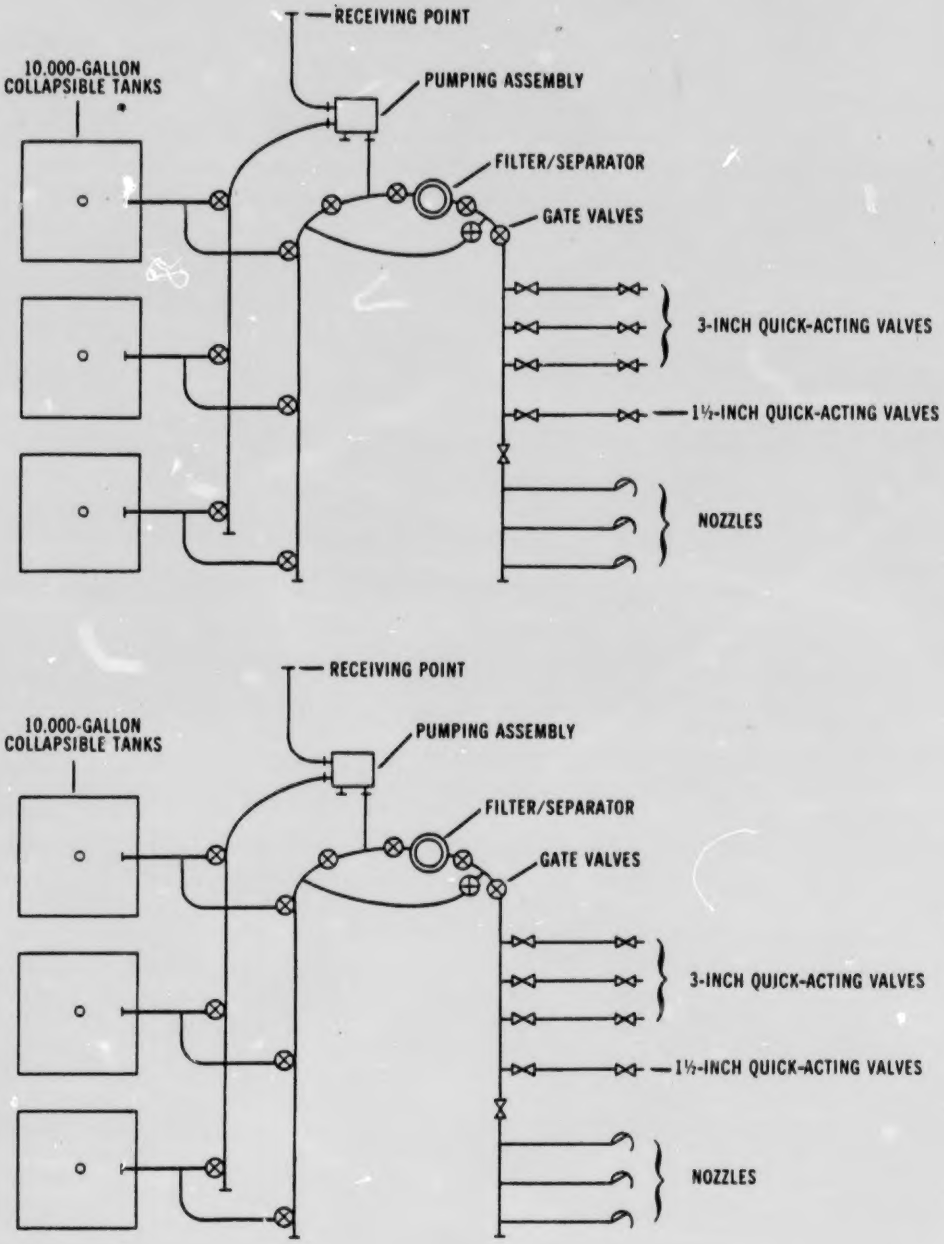

RECEIVING POINT
10,000-GALLON COLLAPSIBLE TANKS
PUMPING ASSEMBLY
FILTER/SEPARATOR
GATE VALVES
3-INCH QUICK-ACTING VALVES
1½-INCH QUICK-ACTING VALVES
NOZZLES
RECEIVING POINT
10,000-GALLON COLLAPSIBLE TANKS
PUMPING ASSEMBLY
FILTER/SEPARATOR
GATE VALVES
3-INCH QUICK-ACTING VALVES
1½-INCH QUICK-ACTING VALVES
NOZZLES

Figure 6-4. Suggested layout for fuel system divided for handling two different fuels or for moving.

CHAPTER 7

UNITS AND VEHICLES USED TO TRANSPORT BULK PETROLEUM

TANK UNITS

Liquid Dispensing Tank Unit for Trailer Mounting

■ **Description.** The tank unit (fig 7-1) consists of one 600-gallon tank (page 7-2); tiedown assemblies; one 2-inch suction hose, 12 feet long; one reducing coupler; and a 1 1/2-inch dispensing nozzle, with dust cap and chain, and bonding wire. If the nozzle has a lock-on, latch-open device, the device must be fixed so that it can't be used. The 600-gallon tank is placed in a cargo trailer with the tank outlet toward the front of the trailer (fig 7-2). More information on the tank unit is in TM 5-4930-220-12.

1. 600-GALLON TANK
2. GRAVITY DISPENSING HOSE, REDUCING COUPLER, AND 1½-INCH NOZZLE FOR TANK UNIT
3. GROUND RODS
4. DRUM SUCTION STUB
5. PUMPING ASSEMBLY
6. SUCTION HOSES AND METER HOSE
7. FIRE EXTINGUISHER
8. TIEDOWN ASSEMBLIES FOR TRAILER
9. TIEDOWN ASSEMBLIES FOR TRUCK

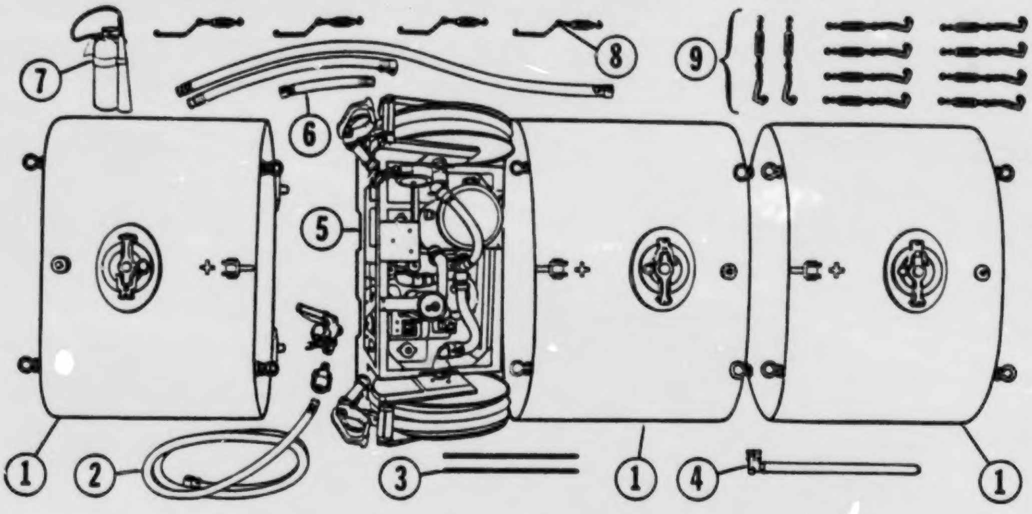


Figure 7-1. Tank unit and tank and pump unit.

CHAPTER 7

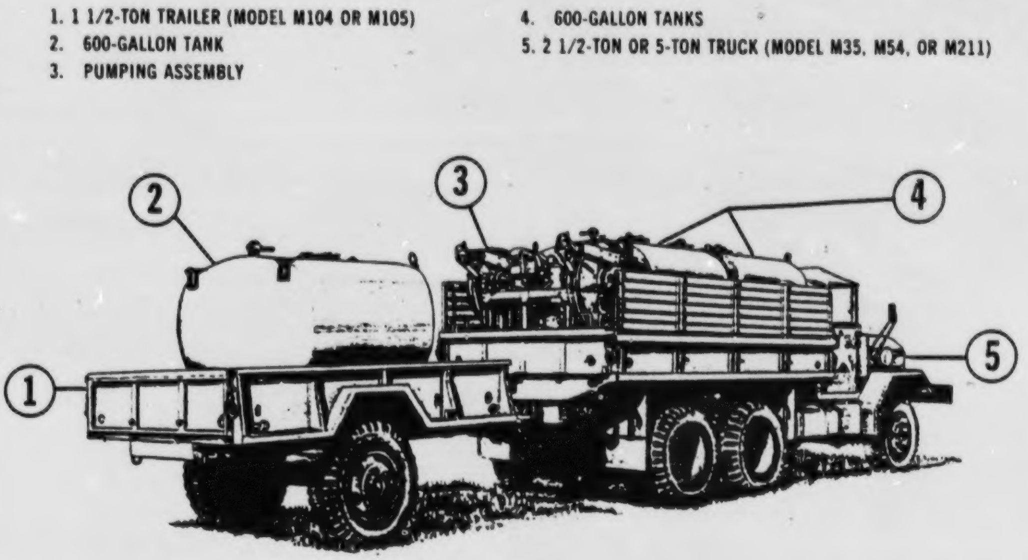

1. 1 1/2-TON TRAILER (MODEL M104 OR M105)
2. 600-GALLON TANK
3. PUMPING ASSEMBLY
4. 600-GALLON TANKS
5. 2 1/2-TON OR 5-TON TRUCK (MODEL M35, M54, OR M211)
2
3
4
1
5

Figure 7-2. Mounted tank unit and tank and pump unit.

☐ When the tank unit is used with the tank and pump unit, the 12-foot suction hose is attached to the tank outlet and to a 2-inch inlet of the pumping assembly (page 7-2).

☐ When product is to be dispensed from the tank unit by gravity, one end of the 12-foot suction hose is connected to the tank outlet, and the reducer (2-inch female to 1 1/2-inch male) is attached to the other end of the hose. The 1 1/2-inch dispensing nozzle can then be coupled to the suction hose.

■ **Use.** The tank unit is used with 1 1/2-ton, two-wheel, M104 and M105 cargo trailers. The mounted unit (fig 7-2) can be used with the tank and pump unit. The unit can be used by itself to dispense by gravity.

Liquid-Dispensing Tank and Pump Unit for Truck Mounting

■ **Description.** The tank and pump unit (fig 7-1) consists of a 50-gpm pumping assembly, two 600-gallon tanks, and related equipment. There are several standard models of the tank and pump unit. The main differences are in their filter/separator, hose reels, pump, and manifold. TM 10-4930-204-15 gives details on installing, operating, and maintaining the different models of the unit. A general description of the components is given below.

☐ **50-gpm pumping assembly.** The pumping assembly (fig 7-3) includes the pump and engine assembly, filter/separator, hose reels, ground reels, hose and fittings, and related equipment.

970

1. GROUND REEL
2. FILTER/SEPARATOR
3. HOSE REEL
4. HOSE GUIDE ROLLERS
5. NOZZLE AND HOSE
6. INSTRUCTION PLATE AND TOOL COMPARTMENT DOOR
7. MANIFOLD
8. BASE PLATE
9. ENGINE/PUMP
10. LIFTING LOOPS

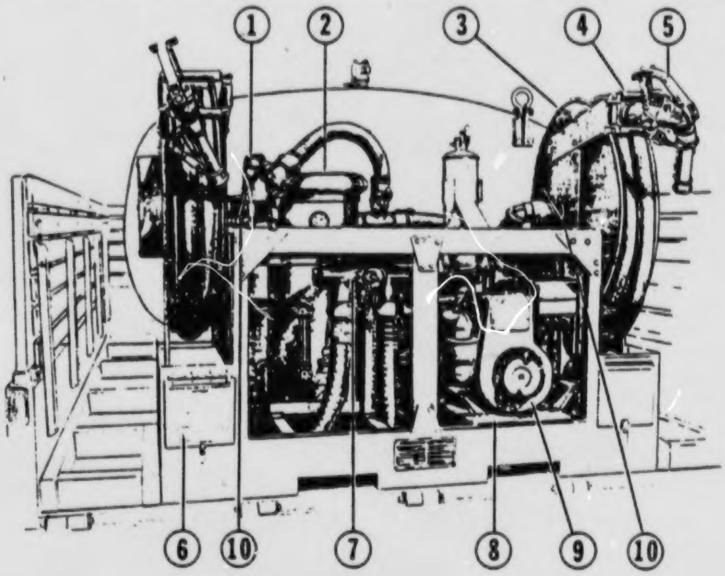


Figure 7-3. Pumping assembly.

• **Pump and engine assembly.** The pump is a 50-gpm, self-priming, centrifugal pump. The impeller is screwed on the extension of the engine crankshaft. The engine is a one-cylinder, four-cycle, air-cooled, hand-cranked engine. Some models have two-cylinder, four-cycle, overhead-valve, air-cooled engines. A radio-shielded magneto supplies the ignition spark, and a governor controls the engine speed by varying throttle openings to suit pump loads. The gasoline tank holds 1 gallon. The pump and engine are mounted on a common base so that they can be easily removed for servicing and can be used in other pumping operations.

• **Filter/separator.** The filter/separator is a vertical, 50-gpm-capacity unit with four standard canisters and filter elements (page 2-1). The tank and pump unit can be used to refuel aircraft because the filter/separators qualify under military specification MIL-F-8901C.

• **Manifold.** The manifold controls the flow of product to the suction side of the pump. Two quick couplers provide connections or inlets for the tank suction lines. The product flows from either or both tanks to the pump suction through the manifold outlet and a section of hose. Some models have a discharge hose that runs from the filter/separator to the manifold,

994

and product can be discharged from the manifold outlet when the three-way valve is used to close off the suction side. Other models use only the manifold for suction.

- **Hose reels.** The dispensing hoses are stored on two hose reels, each with a recoil tension spring. A 40-foot length of 1 1/2-inch noncollapsible discharge hose is used on each reel. Product from the filter/separator enters through a pipe at the hub of the reel and is discharged through the hoses.

- **Ground reel.** A ground reel is attached to the frame of the pumping assembly so that the tank and pump unit can be grounded. One section of the ground wire must be clipped to a ground rod near the tank and pump unit before the other section is connected to the vehicle being fueled.

- **Metering kit.** The metering kit consists of a meter, hose assembly, couplers, capscrews, and washers. The kit is used with pumping assemblies on all tank and pump units.

- **Related items of equipment.** Other items issued with the pumping assembly are a drum-unloader suction stub for emptying 55-gallon drums, two dispensing nozzles, a starter rope, a carbon dioxide fire extinguisher, and tiedown assemblies (fig 7-1). If the nozzles have lock-on, latch-open devices, the devices must be fixed so that they must be held open by hand and attended at all times.

☐ **600-gallon tanks.** Two of these welded aluminum, skid-mounted tanks (fig 7-1) come with the tank and pump unit. The tank shell has a manhole assembly, pump-port drain plug, and discharge valve assembly. Controls for the discharge valve are on the top of the tank. The discharge valve outlet is at the bottom rear of the tank, and the drain plug is at the bottom front. A baffle inside the shell helps keep down the surge of product during transport. Two lifting rings are attached to the top of each end of the shell to make handling easier. Tiedowns are provided for securing the tanks in the vehicle bed.

■ **Use.** The tank and pump unit is used with M41 and M54 5-ton, 6x6 cargo trucks (fig 7-2) and M34, M35, and M211 2 1/2-ton, 6x6 cargo trucks. It is preferable to use the unit with the 5-ton cargo trucks instead of the 2 1/2-ton trucks because when the unit is filled with fuel it exceeds both the cross-country and hard surface road ratings of the 2 1/2-ton trucks. The unit can be used to fill and empty 500-gallon collapsible drums, 55-gallon drums, and 5-gallon cans; temporarily store product; refuel ground vehicles; and replace or supplement special-purpose vehicles. The unit may also be used to fuel aircraft if no other aircraft refueling equipment is available. ①

972

TANK TRUCKS

M49A2C Tank Trucks

■ **Description.** The M49A2C tank truck (figs 7-4 and 7-5) is mounted on a modified M45A2 chassis. The truck has a multifuel engine with single front and dual rear tires. It is about 23 feet long, 8 feet wide, and 7 2/3 feet high. TM's 9-2320-209-10 and 10-1113 give details on this tank truck.

☐ **Tank body and equipment.** The tank body is a stainless steel 1,200-gallon

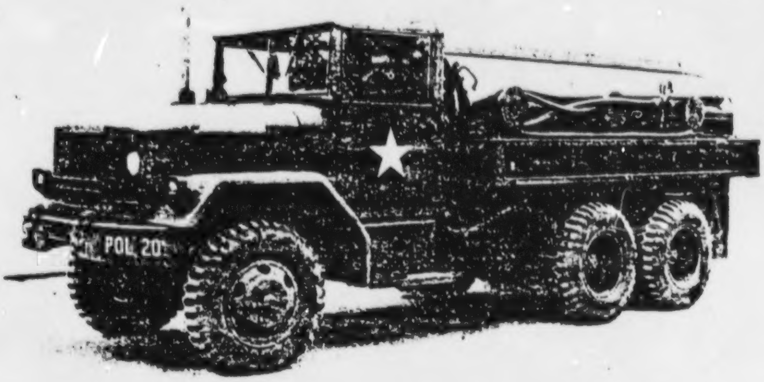


Figure 7-4.
Left front view of M49A2C tank truck.

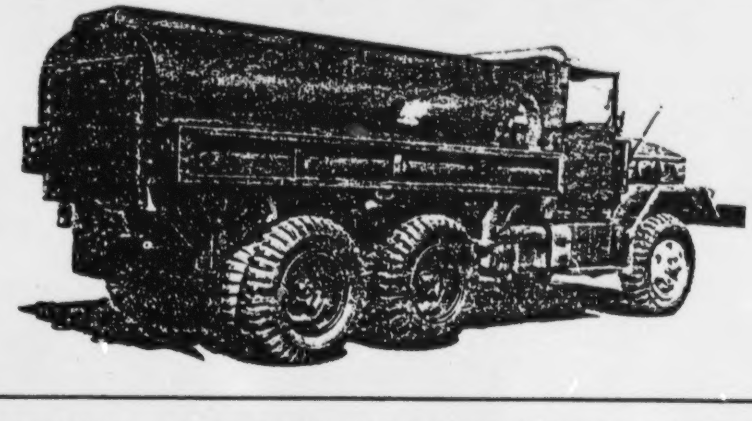


Figure 7-5.
Right rear view of M49A2C tank truck.

NOTE: This FM uses the terms "curbside," "roadside," "left side," and "right side." Curbside and roadside refer to the right and left sides, respectively, of a vehicle parked at the curb on the right side of a two-way street. The left side of a tractor is the driver's side.

996

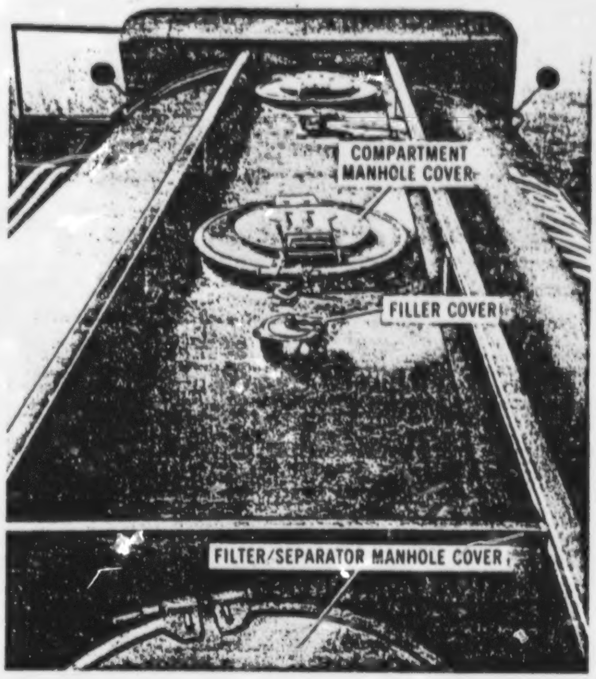


Figure 7-6.
Manhole and filler covers of tank compartments on M49A2C tank truck.

shell divided into two 600-gallon compartments. Each compartment has a manhole and filler cover assembly (fig 7-6). There is a walkway on each side of the tank body. One 5-pound carbon dioxide fire extinguisher is mounted on the left rear and one is mounted on the right front of the body walkways. An equipment compartment or cabinet is located at the rear of the tank body. This compartment houses the fuel delivery system of the tank truck. The components of this system and their location in the rear compartment are shown on figure 7-7.

☐ **Delivery pump.** A rotary positive-displacement pump located in the rear equipment compartment (fig 7-7) pumps fuel from the tank truck. The pump is rated at 60 gpm at 700 revolutions per minute (rpm). The speed of the pump is controlled by a speed-control linkage assembly.

☐ **Filter/separator.** There is also an upright filter/separator in the rear equipment compartment (fig 7-7) of the M49A2C tank truck. It has three filter elements, three go-no-go fuses, a pressure gage, and an automatic dump valve.

☐ **Hose and nozzle assembly.** A 35-foot length of 1 1/2-inch reinforced hose with a standard 1 1/2-inch automatic nozzle is mounted on the left side of the tank body.

■ **Use.** The M49A2C tank truck is used mainly for transporting bulk petroleum and

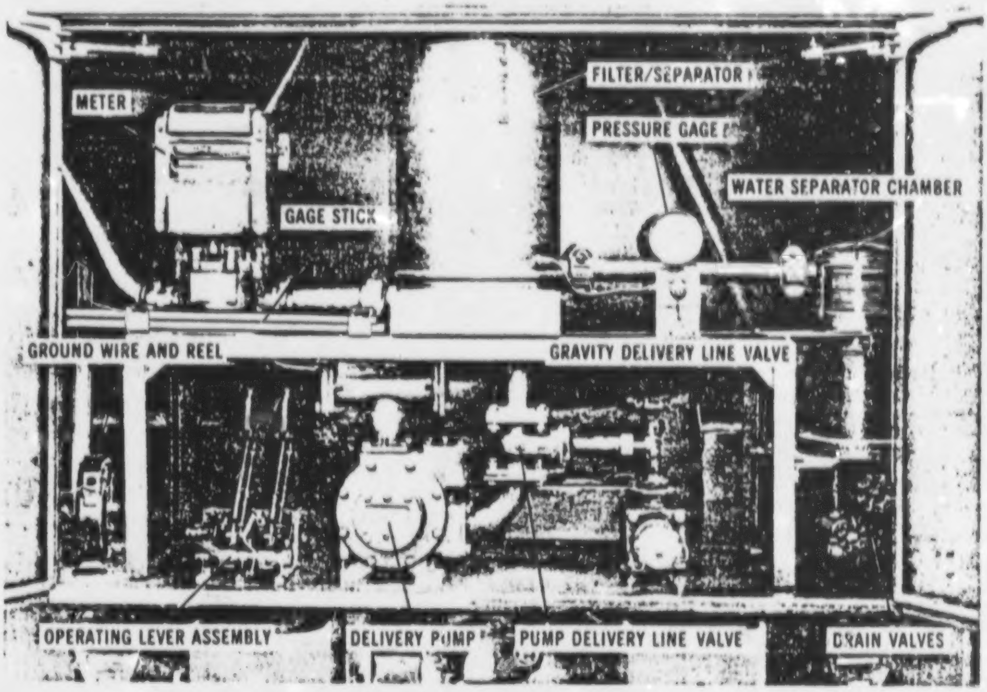

METER
FILTER/SEPARATOR
PRESSURE GAGE
WATER SEPARATOR CHAMBER
GAGE STICK
GROUND WIRE AND REEL
GRAVITY DELIVERY LINE VALVE
OPERATING LEVER ASSEMBLY
DELIVERY PUMP
PUMP DELIVERY LINE VALVE
DRAIN VALVES

Figure 7-7. Rear equipment compartment of M49A2C tank truck.

general refueling. The truck can carry bulk petroleum both on and off the road. However, it can carry only 600 gallons when it travels off the road because the forward tank must be left empty. The truck can be used to fill and empty 500-gallon collapsible drums and 55-gallon drums and to refuel ground vehicles. The tank truck is used also in the open-port refueling of aircraft. More information on M49A2C tank truck and aircraft refueling is in FM 10-68.

M559 Tank Truck (GOER)

■ **Description.** The M559 tank truck (fig 7-8), also called the GOER, is an on-the-road and off-the-road, all-weather and all-terrain, articulated vehicle with two- or four-wheel drive. Articulated means that the tank truck has two bodies—a tractor and a trailer—which are jointed in the middle. Each section can roll by itself so that all four wheels are always on the ground. The truck has a six-cylinder, four-cycle, liquid-cooled, turbocharged, diesel engine. It can haul and dispense 2,500 gallons of bulk petroleum and can float or swim on inland waterways with or without the payload. It is about 32 1/2 feet long and 9 feet wide and has a top highway cruising range of 300 miles. Details on the operation and maintenance of the M559 tank truck are in TM 9-2320-233-10. The components of the vehicle are discussed below.

☐ **Tank body and equipment.** The tank is a stainless steel, 2,500-gallon shell divided by one horizontal and one

975

CHAPTER 7

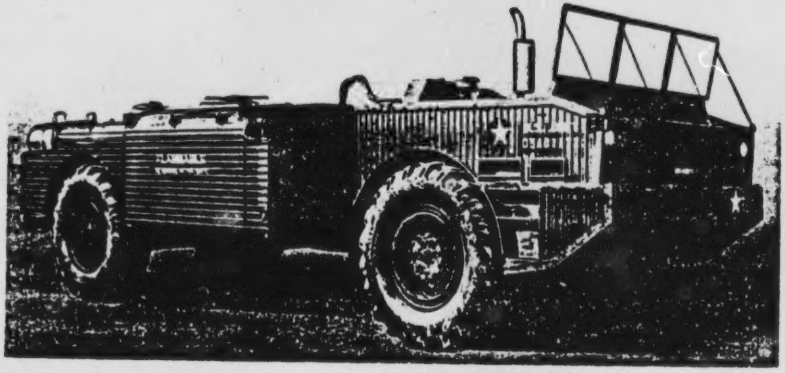


Figure 7-8.
M559 tank truck (GOER).

vertical baffle. A manhole cover and two fuel vent covers are located on top of the tank (fig 7-9). A cabinet just behind the tank houses three pressure discharge outlets, gate valves, and the vehicle's fuel delivery manifold system. A gravity discharge outlet, used to dispense bulk fuel to storage sites, is located in back of the rear axle on the bottom of the tank. There are three storage cabinets at the rear of the vehicle (fig 7-9). They house the vehicle's dispensing hose. There is space on the right and left rear of the vehicle for two 55-gallon drums or packaged petroleum products (fig 7-9). Two 15-pound carbon dioxide fire extinguishers are mounted in the front and rear of the tank body.

☐ **Delivery pump.** Fuel is pumped from the vehicle by a 300-gpm centrifugal pump located behind the hose reel assembly of the right rear cabinet. The pump is hydraulically driven and is started by a control lever in the operator's compartment. All fuel moving through the pump must go through the filter/separator.

☐ **Filter/separator.** A filter/separator is located on top of the tank body (fig 7-9) of the M559 tank truck. It has 15 replaceable elements and canisters, a pressure-differential indicator, and an automatic dump valve. The indicator shows at a glance when the filter elements need to be changed. A yellow button appears when the pressure differential equals or exceeds 20 pounds per square inch (psi). This means the elements are starting to wear but do not need to be changed. A red button appears when the pressure equals or exceeds 35 psi. This means the elements must be changed immediately. The automatic dump valve on the filter/separator is float operated. When too much water is collected, the float closes the separator fuel outlet and automatically dumps the water.

☐ **Discharge and suction hoses.** The tank truck has three discharge hoses and two suction hoses. Two 25-foot sections of 1 1/2-inch discharge hose, with a 50-gpm capacity, are located in reel assemblies in the right and left rear cabinets of the tank truck. One 25-foot section of 2-inch discharge hose, with a 100-gpm capacity, is located on a reel assembly in the center rear cabinet of the tank truck. These discharge hoses have fuel-dispensing nozzles. Two 15-foot sections of 3-inch suction hose, with a 300-gpm capacity, are stored in tubes above the discharge-hose reel assemblies.

- **Use.** The M559 tank truck is used to haul and dispense bulk petroleum products. It is highly mobile and can move on all types of terrain with a full payload. The tank truck is very useful in transporting bulk fuels over areas where conventional tank trucks cannot operate. The tank truck can use its discharge hoses to dispense fuel to three vehicles at the same time. It can use its suction hose to fill one storage tank. Because it is equipped with a filter/separator, the tank truck can also be used in aircraft refueling operations. Ⓨ

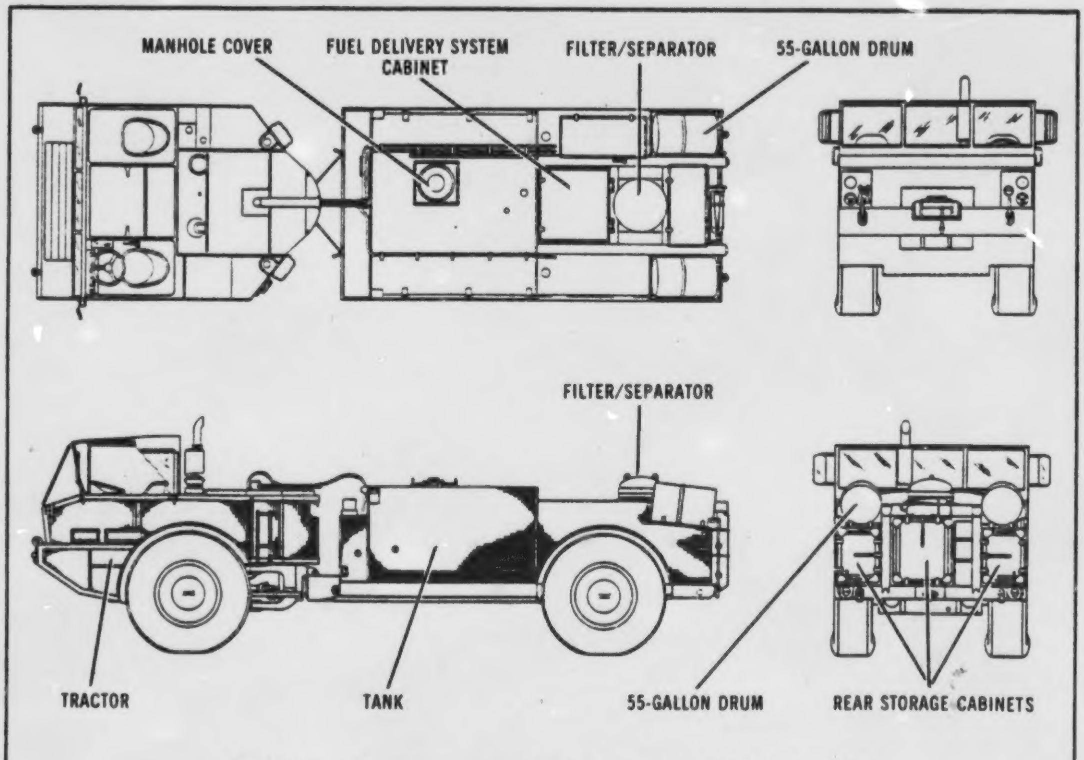

MANHOLE COVER
FUEL DELIVERY SYSTEM CABINET
FILTER/SEPARATOR
55-GALLON DRUM
FILTER/SEPARATOR
TRACTOR
TANK
55-GALLON DRUM
REAR STORAGE CABINETS

Figure 7-9. Front, rear, top, and side views of the M559 tank truck.

CHAPTER 7

TANK SEMITRAILERS

M131A5C Tank Semitrailer

■ **Description.** This vehicle (figs 7-10 and 7-11) is a 12-ton, 4-wheel, 5,000-gallon fuel-tank semitrailer. It is towed by an M52 5-ton, 6X6 tractor truck or a like vehicle that has a fifth wheel. The semitrailer is about 31 feet long, 8 feet wide, and 9 feet high. TM's 9-2330-272-14 and 10-1113 have details on this tank semitrailer.

☐ **Tank body and equipment.** The tank body of the M131A5C is made of stainless steel, and it is divided into two 2,500-gallon compartments. Each compartment has a 20-inch manhole cover and a filler cover with a vent valve (fig 7-12). The top of the tank body has a steel grate so that personnel do not slip when they walk on the walkway. The walkway is reached by a ladder at the rear of the vehicle and gives access to the manhole covers. There are two equipment cabinets mounted on each side of the tank vehicle (figs 7-10 and 7-11). These cabinets hold the semitrailer discharge and loading system. The components of this system, located in the roadside equipment cabinet, are indicated on figure 7-13. Figure 7-14 shows the system components located in the curbside equipment cabinet. A hose compartment is also mounted on the tank body above the roadside equipment cabinet (fig. 7-10). The hose compartment is horizontally divided into three tubes which house three 15-foot lengths of suction hose and a gage stick.

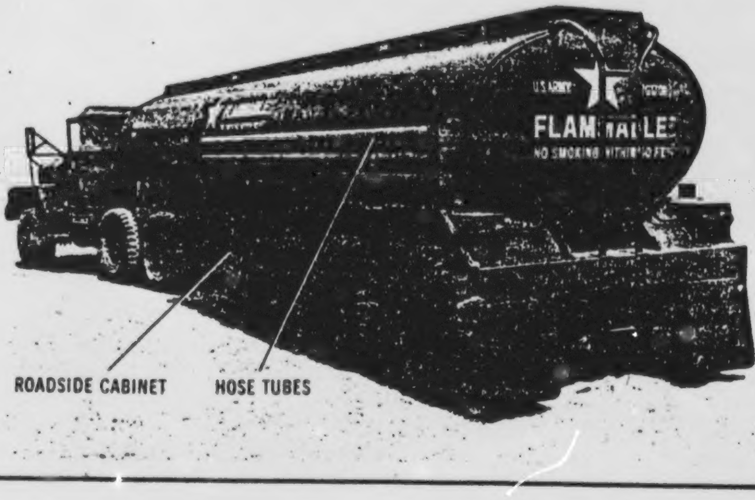


Figure 7-10. Left rear view of the M131A5C tank semitrailer.

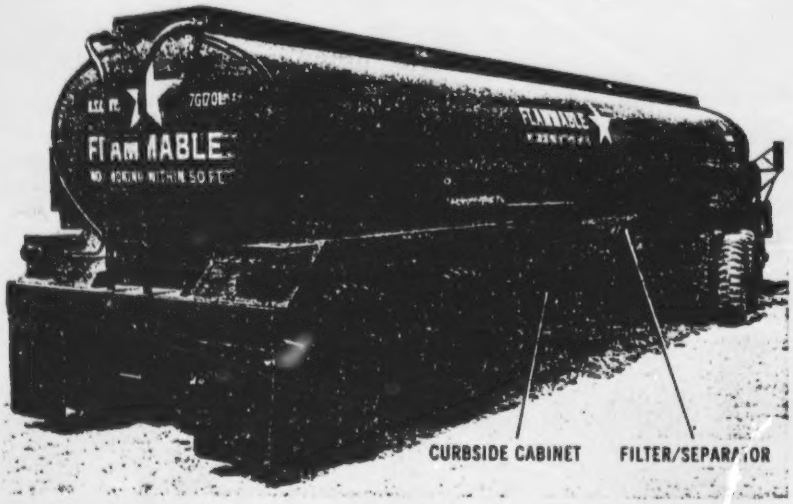

CURBSIDE CABINET
FILTER/SEPARATOR

Figure 7-11.
Right rear view of the M131A5C tank semitrailer.

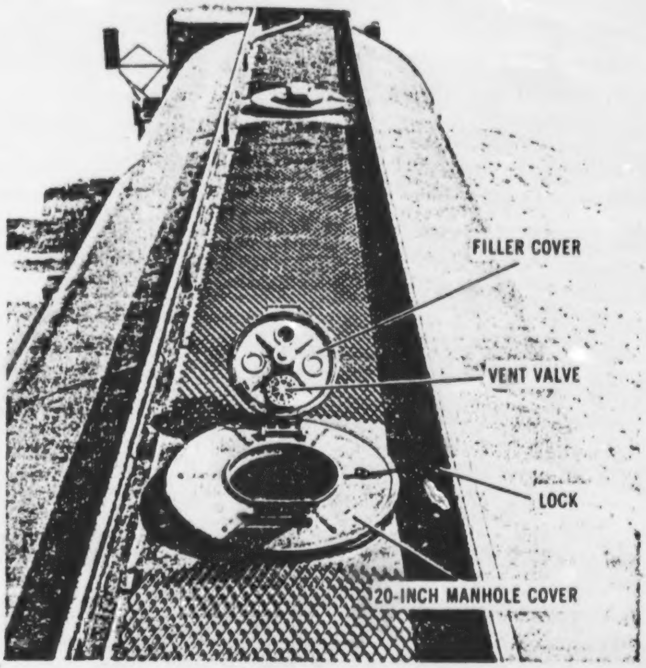

FILLER COVER
VENT VALVE
LOCK
20-INCH MANHOLE COVER

Figure 7-12.
Manhole covers and walkway of the M131A5C and M131A5 tank semitrailer.

1. 1½-INCH NOZZLE
2. 1½-INCH HOSE ON REEL (0 TO 55-GPM DISPENSING)
3. HOSE REEL HANDCRANK ATTACHED TO SHAFT
4. FIRE SYSTEM NOZZLE
5. CONTROL AND INSTRUMENT PANEL
6. RATE-OF-FLOW SELECTOR VALVE
7. METER
8. 225-GPM CUTOFF VALVE HANDWHEEL
9. FIRE SYSTEM NOZZLE
10. 2½-INCH HOSE ON REEL (225-GPM DISPENSING)
11. 2½-INCH NOZZLE
12. HOSE REEL CRANKSHAFT
13. PUMP INTAKE VALVE
14. PUMP CUTOFF VALVE HANDWHEEL
15. REAR COMPARTMENT MANIFOLD VALVE HANDWHEEL
16. HOSE REEL HANDCRANK CLAMPS
17. GRAVITY DISCHARGE VALVE
18. 3-WAY VALVE LEVER
19. FRONT COMPARTMENT MANIFOLD VALVE HANDWHEEL
20. PUMP DISCHARGE VALVE
21. STATIC REEL
22. EMERGENCY DUMP VALVE OPERATING LEVERS
23. FIRE EXTINGUISHER

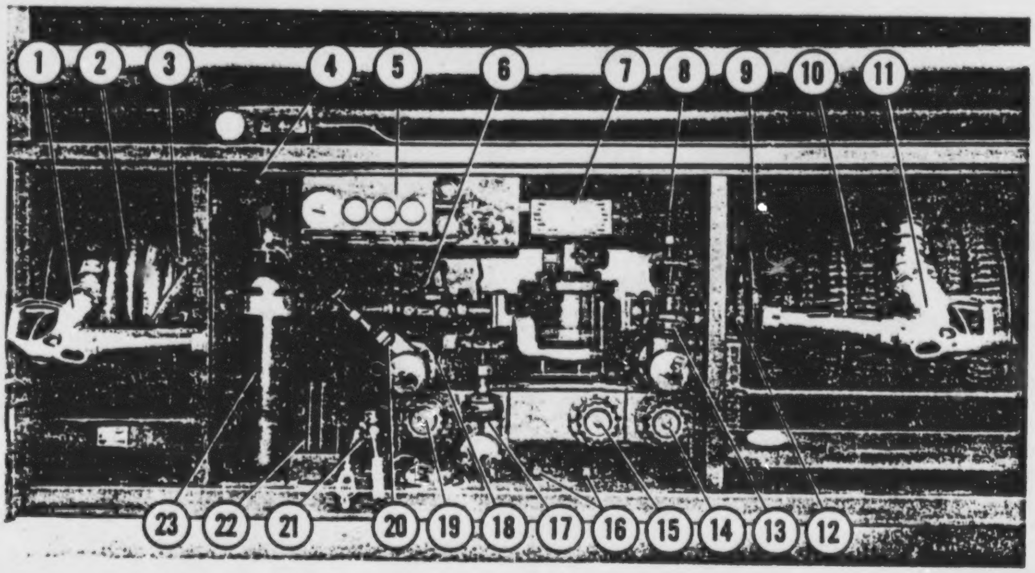
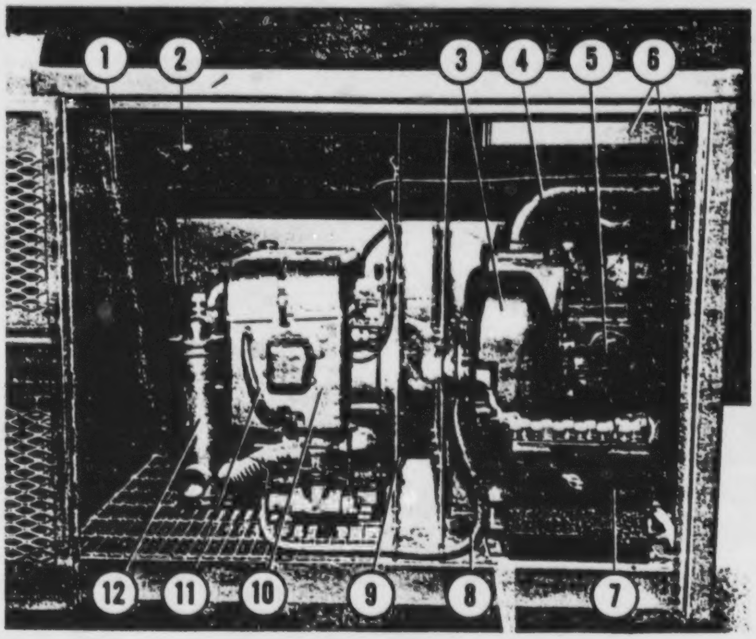


Figure 7-13. Roadside equipment cabinet of the M131A5C tank semitrailer.

☐ **Auxiliary engine and pump assembly.** The pump and engine assembly is located in the curbside cabinet (fig 7-14). It is used to pump product into or out of the compartments. The assembly has a two-cylinder, four-cycle, horizontally opposed, air-cooled engine and a self-priming 225-gpm centrifugal pump. The pump is connected directly through a shaft mounted on a bearing. The engine and pump are separated by a firewall.

☐ **Filter/separator.** A filter/separator is mounted on the right side of the tank body on the M131A5C tank semitrailer (fig 7-11). The filter/separator has 15 first-stage (coalescer) elements and 5 second-stage canister elements. The unit also has 15 third-stage go-no-go fuses mounted in the second-stage canister elements. The filter/separator operating pressure is 75 psi and its capacity is 300 gpm.



1. EXHAUST
2. FIXED FIRE EXTINGUISHER NOZZLE
3. CENTRIFUGAL PUMP
4. PUMP DISCHARGE LINE
5. PUMP SUCTION LINE
6. FUEL TANK AND SEDIMENT BOWL
7. BATTERY
8. BATTERY LEAD
9. FIREWALL PANELS
10. ENGINE
11. SPARK PLUG CABLE
12. BREATHER

Figure 7-14. Curbside equipment cabinet of the M131A5C tank semitrailer.

☐ **Dispensing hose and reels.** The M131A5C tank semitrailer has a 2 1/2-inch and a 1 1/2-inch dispensing hose reel. Both reels are stored in the roadside equipment cabinet (fig 7-13). The 2 1/2-inch dispensing hose reel holds a 50-foot section of 2 1/2-inch dispensing hose. This hose has a 2 1/2-inch nozzle and its discharge capacity is 225 gpm. The 1 1/2-inch dispensing hose reel holds a 50-foot section of 1 1/2-inch dispensing hose. This hose has a 1 1/2-inch nozzle and is used for low-rate discharge (0 to 55 gpm).

■ **Use.** The M131A5C tank semitrailer is used to carry and transfer fuel, service containers, and refuel ground vehicles. The semitrailer can travel cross country at a reduced payload of 3,300 gallons (1,650 gallons in each tank compartment). It can fill or empty 3,000-, 10,000-, and 50,000-gallon collapsible tanks. The vehicle can transfer product to or receive it from the fuel system supply point. Also, the semitrailer can be used in the open-port refueling of aircraft that can take on fuel at rates of 225-gpm. FM 10-68 has more information on the M131A5C tank semitrailer and aircraft refueling.

CHAPTER 7

M131A5 Tank Semitrailer

■ **Description.** The M131A5 tank semitrailer, (figs 7-15 and 7-16) is a 12-ton, 4-wheel, 5,000-gallon fuel tank semitrailer. This model is like the M131A5C, except that it does not have a filter/separator, meter, dispensing hoses, reels, and dispensing nozzles. It has only one equipment cabinet which is located on the curbside of the vehicle (fig 7-16). The cabinet holds the semitrailer discharge and loading system. Figure 7-17 shows the system components located in the rear area of the cabinet. Figure 7-18 shows the system components in the front area of the cabinet. Information on the M131A5 tank semitrailer is in TM's 9-2330-272-14 and 10-1113.

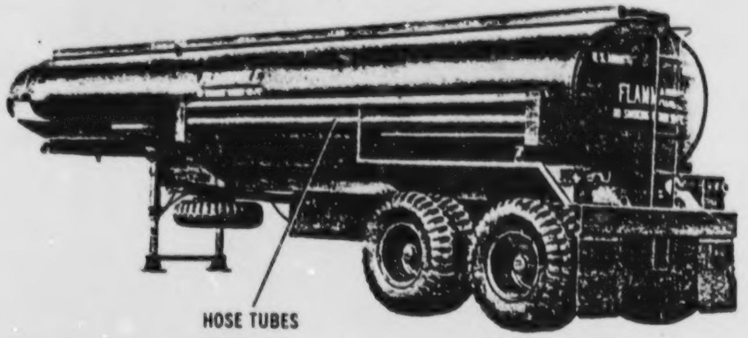


Figure 7-15.
Left rear view of the M131A5 tank semitrailer.

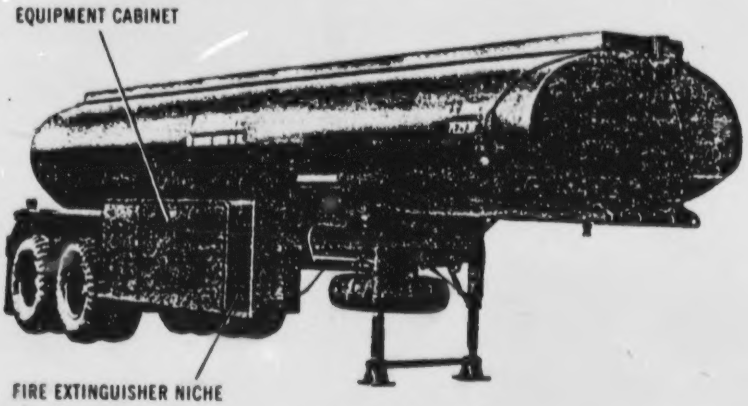


Figure 7-16.
Right front view of the M131A5 tank semitrailer.

982

■ **Use.** The M131A5 tank semitrailer is used only to transport and transfer fuel. It cannot be used to refuel ground vehicles or aircraft. The vehicle is mainly used for long haul distribution of bulk petroleum. It has the same cross-country capability as the M131A5C. The semitrailer can fill or empty 3,000-, 10,000-, and 50,000-gallon collapsible tanks, and it can also service the fuel system supply point.

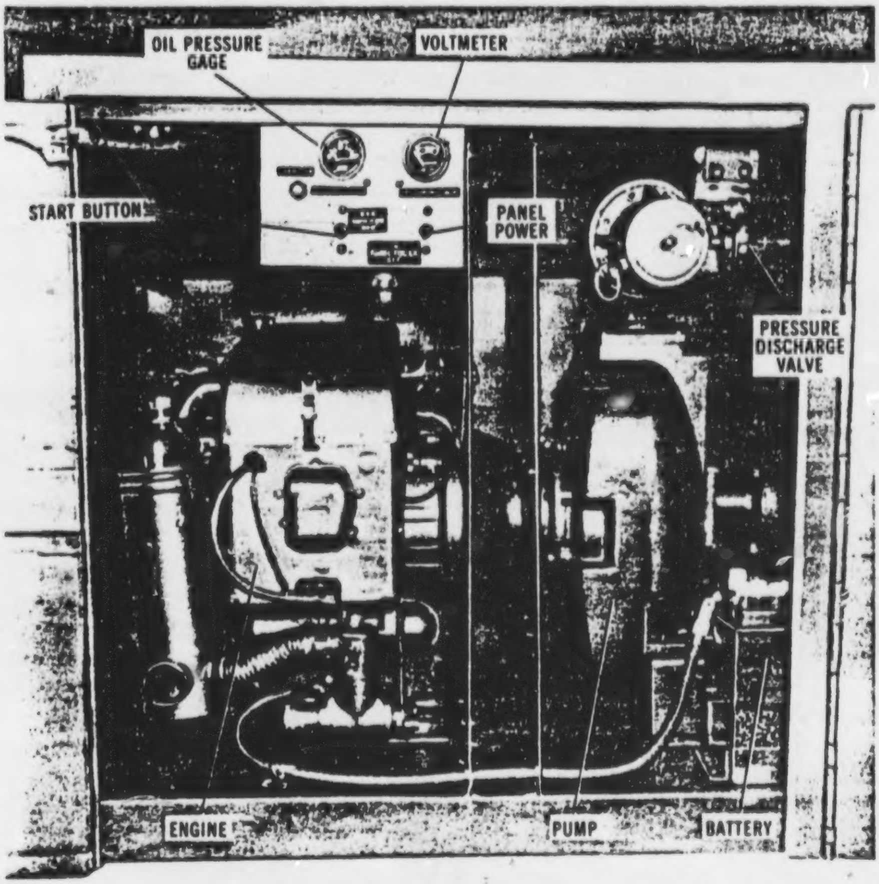

OIL PRESSURE GAGE
VOLTMETER
START BUTTON
PANEL POWER
PRESSURE DISCHARGE VALVE
ENGINE
PUMP
BATTERY

Figure 7-17. Rear area of curbside cabinet of the M131A5 tank semitrailer.

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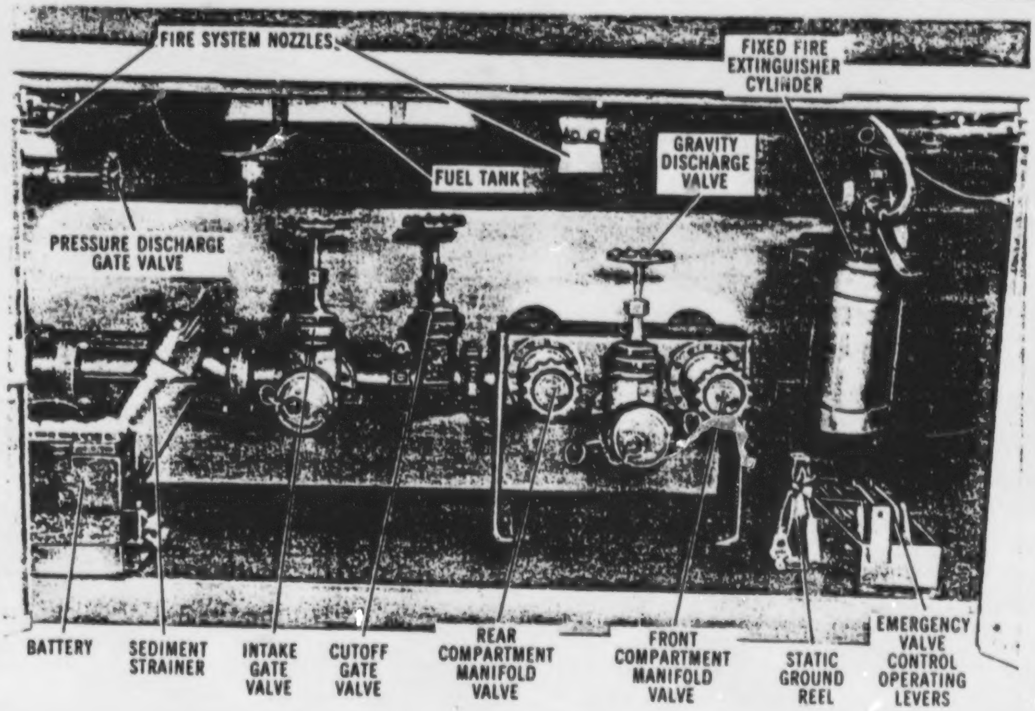

FIRE SYSTEM NOZZLES
FIXED FIRE EXTINGUISHER CYLINDER
FUEL TANK
GRAVITY DISCHARGE VALVE
PRESSURE DISCHARGE GATE VALVE
BATTERY
SEDIMENT STRAINER
INTAKE GATE VALVE
CUTOFF GATE VALVE
REAR COMPARTMENT MANIFOLD VALVE
FRONT COMPARTMENT MANIFOLD VALVE
STATIC GROUND REEL
EMERGENCY VALVE CONTROL OPERATING LEVERS

Figure 7-18. Front area of curbside cabinet of the M131A5 tank semitrailer.

1007

CHAPTER 7

TANK CARS

Description

Tank cars vary in capacity and design. Those used for petroleum products usually have one compartment and range in capacity from 6,000 to 16,000 gallons. However, some tank cars have more than one compartment and may carry more than one product at a time. The designs vary from narrow-gage foreign service to broad-gage foreign service and standard-gage domestic service. Some tank cars have heaters to liquefy viscous products, but those without heaters are generally used. Figure 7-19 shows a typical petroleum tank car. Tank car components are discussed below.

- **Dome.** Each tank car compartment has a dome (fig 7-20) to allow space for the product to expand as the temperature rises. The tank shell can thus be filled to the top. Each dome has a manhole through which the tank compartment may be loaded, unloaded, inspected, cleaned, and repaired. Dome covers may be hinged and bolted on or sc[illegible] on. Most domes have vents and safety valves to let out vapors.

- **Safety Valve.** The safety valve used on most tank cars consists of a springloaded poppet valve which opens at a preset pressure. As pressure in the dome builds up to a point above the pressure setting of the valve, the valve is forced off the valve seat. This lets the excess vapors escape. The spring closes the valve automatically when the pressure drops to a level equal to the valve setting.

- **Bottom Outlet.** Each compartment has a bottom outlet, and the compartment is usually loaded and unloaded through it. The

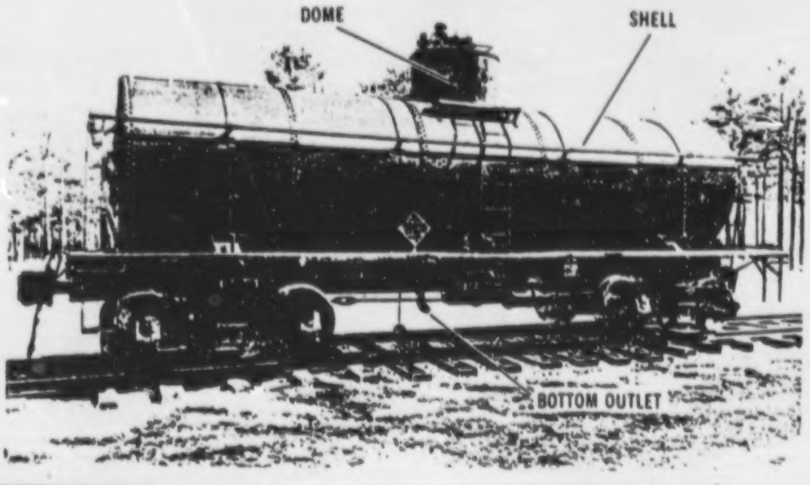


Figure 7-19.

Typical petroleum tank car.

outlet valve (fig 7-20) is controlled by a valve rod handle or valve rod handwheel. The outlets on tank cars used in the United States are 5 inches in diameter. Outlets on tank cars used overseas are generally 4 inches in diameter. All outlets have male threads. A tank car elbow assembly is used to adapt a pump suction line to the 5-inch outlet. A 4- by 5-inch adapter must be installed between the elbow assembly and the tank car 4-inch outlet.

Use

Tank cars are used mainly to supplement petroleum pipeline transportation when rail facilities are available. They can be loaded and unloaded at a tactical class III supply point by a portable pumping assembly. Tank cars may be used also for temporary storage. A tank car should be used to carry only one type of product. If this is not possible, the car must be inspected and cleaned before a different product is put in it to avoid contamination. (See MIL-HDBK-200.)

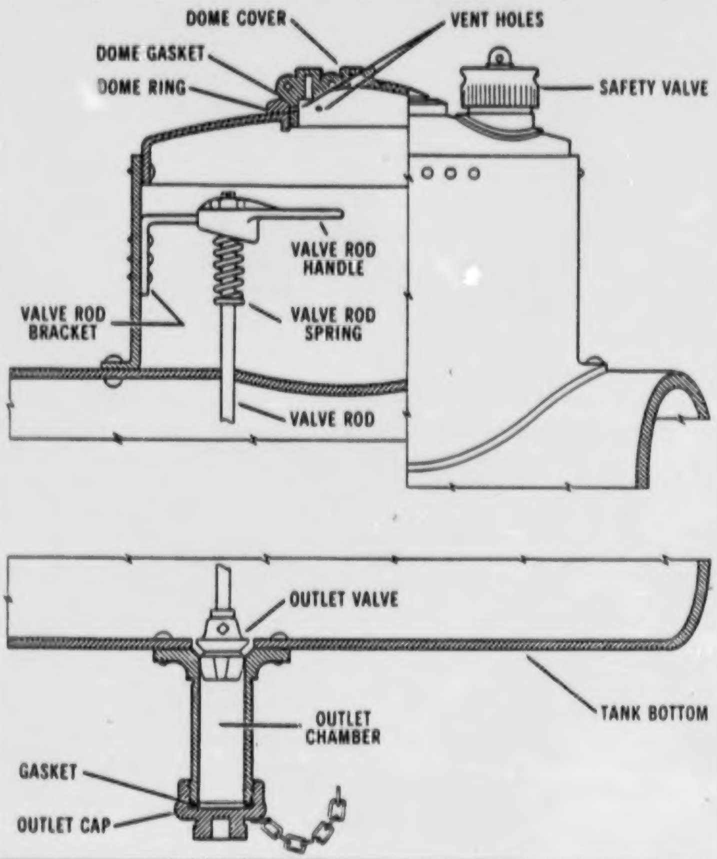

DOME COVER
VENT HOLES
DOME GASKET
DOME RING
SAFETY VALVE
VALVE ROD HANDLE
VALVE ROD BRACKET
VALVE ROD SPRING
VALVE ROD
OUTLET VALVE
TANK BOTTOM
OUTLET CHAMBER
GASKET
OUTLET CAP

Figure 7-20.

Tank car dome and bottom outlet.

986

CHAPTER 10

SAFETY

INTRODUCTION

General

The handling of petroleum products presents many hazards, but you can safely handle both bulk and packaged products if you understand their characteristics and take proper precautionary measures. If your job is the receipt, storage, or issue of flammable and combustible petroleum products, you must know and observe the safety precautions in this chapter and in chapters dealing with specific operations. See FM 10-68 for the hazards of handling JP-4.

Flammable and Combustible Products

Hazardous liquids are classified by the National Fire Protection Association (NFPA No. 30) as flammable or combustible. These are described in table 10-1. A flammable liquid is one with a flashpoint below 100° F (37.8° C) and a vapor pressure not above 40 psi (absolute) at 100° F. A combustible liquid is one with a flashpoint at or above 100° F (37.8° C). Liquids are more volatile when heated, and when class II and class III liquids are heated, they are subject to the same requirements as for class I liquids.

Vapor Explosive Range

When vapors from petroleum products are mixed with the proper amounts of air, they form explosive mixtures within a limited range. This range is usually called the explosive range or explosive limits. (As used here, the word "explosion" means the instantaneous burning of a mixture of flammable material and air.) Gasoline vapors form explosive mixtures when mixed with air in a range from about 1 to 8 percent by volume. There is a point above which the mixture does not ignite because it is too rich. This point is called the upper explosive limit. For example, a gasoline-air mixture with more than 8 percent gasoline vapors is beyond the upper limit, and it does not ignite. The point below which the mixture does not ignite because it is too lean is called the lower limit. For example, a mixture with less than 1 percent gasoline vapor does not ignite. A mixture within the explosive range ignites at once when it comes in contact with a spark or flame. There is no explosion if the mixture burns in an open space where the hot gases from the combustion have plenty of room to expand. There is an explosion if the mixture ignites in a closed space.

1010

CHAPTER 10

Table 10-1. Flammable and combustible liquids

Classification	Flashpoint (degrees F)	Boiling point (degrees F)
FLAMMABLES:		
Class I	Below 100	
Class IA	Below 73	Below 100
Class IB	Above 73	Above 100
Class IC	At or above 73 and below 100	
COMBUSTIBLES:		
Class II	At or above 100 and below 140	
Class III A	At or above 140 and below 200	
Class III B	At or above 200	

HAZARDS IN HANDLING PETROLEUM PRODUCTS

Fire Hazards

All fires connected with flammable products result from ignition of vapors. There is little danger in a closed container that holds a flammable product unless it is exposed to heat. The hazard arises from the ignition of vapors produced in transfers, use, spills, or leaks. The best way to prevent petroleum fires is to minimize vapor formation and control sources of ignition. Some of the most common sources of ignition are discussed below.

- **Smoking and Matches.** Smoking and matches are the greatest single common cause of fires. You can reduce the danger by keeping all smoking materials out of the class III supply point. Collect all smoking materials at the entrance checkpoint, and give them back to the owner at the exit checkpoint. Also, post NO SMOKING WITHIN 50 FEET signs at all petroleum handling, storing, and displaying areas.

■ **Poor Housekeeping.** Rubbish and similar combustibles supply tinder that can be ignited by small sources of heat. Good housekeeping requires you to put such materials in closed metal containers and get rid of them each day. Wall lockers and cupboards should be fire resistant, and you must never store newspapers and oily waste or rags in them. Burn rubbish in properly designed incinerator or burning pits. Dispose of any petroleum waste according to AR 200-1 or local procedures. Label safety cans or other service containers of flammable liquids having a flashpoint below 100° F (gasoline or JP-4) with Standard Form (SF) 405 (Flammable Liquid). Don't use cans with more than a 10-gallon capacity. Kill weeds and grass in hazardous areas and along highways and railroad tracks with a nontoxic chemical solution such as calcium chloride. You may burn grass and weeds when fire department personnel supervise it.

■ **Mechanical or Friction Sparks.** Sparks caused by friction or impact between metals and other hard substances can ignite flammable products and rubbish. However, mechanical sparks are usually very small and thus have low total heat content in spite of possible temperatures of 2,000° F or more. Do not rely on so-called nonsparking tools; they are no longer required or recommended. The hazard varies with the ignition temperature of the product. The lower the ignition temperature of a product, the greater the hazard of spark ignition. However, just because a product has a high-ignition temperature does not mean there is no chance it will ignite. You must carefully control sources of friction sparks, such as tools and grinding wheels, because of the possibility of igniting combustibles other than flammable vapors.

■ **Electrical Equipment.** Electrical equipment becomes a fire hazard when it arcs, sparks, or overheats. When a current is interrupted, as in a knife switch or circuit breaker, it produces an electric arc of very high temperature. Rotating parts of motors, generators, and the like produce arcs and sparks where the brushes touch the commutators. Arcs and sparks are capable of igniting flammable vapors. Heat generated by a current increases with the amount of current and the resistance encountered. Overloading, therefore, is a hazard in two ways. One hazard is the heat it generates, and the other is the short circuits which result from worn insulation. An oil-insulated switch or circuit breaker, designed to quench arcs from interrupted current, becomes a hazard when overloaded because it tends to vaporize the insulating oil. Never back blown plug fuses with pennies or other conductive materials. Never use fuses with a higher capacity than called for, because they may cause overloading and heating. Fixed and portable lights, power tools, and extension cords present the same hazards. Use only EXPLOSIONPROOF electrical equipment that complies with Underwriters' Laboratory standards where there are flammable vapors. Also, all wiring and grounding must comply with the National Electric Code. Permit only licensed operators to operate generators.

■ **Static Electricity.** Friction causes static electricity. For example, bringing together and separating two unlike substances and almost any motion of persons or material can produce it. Static electricity is also generated by the flow of flammable liquids. Some other causes are the flow of steam, air, or gas through pipe, hose, or tank opening and the movement of vehicles with nonconductive tires over nonconductive road surfaces. You can't prevent static electricity, but it is not a danger until the static electricity builds into a charge that may form a spark. You can prevent sparks by bonding and grounding. Bonding is an electrical connection (a bonding wire) between metallic containers. This equalizes the electrical potential. Grounding is an electrical connection between one or both of the bonded transfer units and the ground. This dissipates electrical potential. When units are properly bonded and grounded, static electricity generated in transfers is conducted from unit to unit and then into the ground. You must set up bonding and grounding before the transfer begins, and break them only after the transfer is completed. Inspect ground wires monthly. If you find any damage, repair it at once. Test the grounding system annually or when it is damaged. To do this, use a multimeter and follow the test procedures in FM 10-68. Static drag chains are not required on military vehicles. Positive bonding and grounding for tank vehicles loading or unloading permit the safe transfer of any static charge that builds up within the tank.

■ **Spontaneous Heating.** Spontaneous heating of a combustible material takes place when its characteristics cause a heat-producing chemical action even though the material has not been exposed to sources of heat. If ignition occurs, it is called spontaneous combustion. The causes of spontaneous heating are few, but the conditions under which they are found are many and varied. There may be more than one factor in some cases, and one may lead to another. The process usually starts with a slow chemical reaction, or slow oxidation, which generates some heat. As the heat builds up, the process speeds up until rapid oxidation takes place. Ignition may occur after days or weeks; during this time, the temperature has been slowly increasing. The process can and does take place in various materials with no danger if the heat it generates can be thrown off. In this case, there can be no ignition. Good ventilation is important. However, a complete lack of ventilation will not prevent spontaneous heating and ignition if a chemical source of oxygen is present. The most common source of spontaneous heating is oil- or paint-soaked waste or rags, particularly those soaked with linseed oil and paint driers. Don't leave oily waste and rags in lockers or supply cupboards. Instead, place them in airtight metal containers for safekeeping.

■ **Welding and Cutting.** Fire hazards are present in all methods of welding. Welding heat can produce vapors; welding can throw off flying globules of metal and slag that can ignite vapors; and its open flame can ignite vapors. If vapors are not ignited immediately, smoldering fires might be started in other combustibles. You must control these hazards since they cannot be eliminated. Make sure storage tanks, tank cars, tank vehicles, drums, and vehicle fuel tanks are thoroughly clean and free of vapor before you do any hot work on them. In addition, get a safety permit from the fire marshal in your area before you do any hot work.

■ **Automatic Nozzles.** The use of automatic petroleum-dispensing nozzles is authorized for all petroleum-dispensing systems. However, the use of a lock or latch-open device that permits unattended operation is NOT AUTHORIZED.

Health Hazards

Health hazards are inherent in petroleum products. You can't eliminate them, so you must be aware of them and use approved safeguards and precautions. Petroleum health hazards can be largely classified as to whether the contaminant takes the form of a dust, a gas or vapor, or a liquid. A contaminant can be classified further as to whether its physiological effect is toxic, anesthetic, or irritant. Physiological effects are concerned with the functions of organs, tissues, and cells of the body. These effects can be produced by inhalation into the lungs, by ingestion into the digestive system, or by contact with the skin. A product may be hazardous to you in more than one form and may produce a combination of effects. Therefore, you must be familiar with the first aid procedures in FM 21-11.

■ **Dusts.** Dusts are solid particles of substance that result from such mechanical operations as grinding, scraping, buffing, riveting, rivet cutting, or drilling; from handling dust-producing materials (as in sanding or sandblasting); or from the evaporating or burning of liquids and residues that contain finely divided substances. Consider the chemical makeup and physical properties, length of exposure, and quantity when you evaluate dust hazards. Dusts are divided into three types, depending on whether they are toxic, fibrosis-producing, or irritant.

☐ **Toxic dusts.** Toxic dusts injure organs and tissues of the body when they are inhaled into the lungs. If ingested into the digestive system, they attack the body through the liver. Certain toxic dust may also irritate the skin. Lead, manganese, mercury, arsenic, and their compounds make toxic dusts. One of the most toxic dusts with which you'll come in contact is produced in the cleaning and repairing of tanks that have leaded gasoline. Lead dust and fumes also result from burning sludge from leaded gasoline tanks. The toxic effects of lead build up in the body, but the body can throw off lead poisoning if it is given enough time between exposures. If it isn't, each exposure adds to the effects of the one before it.

☐ **Fibrosis-producing dusts.** A fibrosis-producing dust injures the lungs in such a way that normal tissue is replaced with fibrous or scar tissue. The most common example is dust containing silica. It causes the disease called silicosis. People who run grinding and polishing machines or sanding and sandblasting equipment may be exposed to such dusts.

☐ **Nuisance dusts.** These dusts may not cause severe injury, but they may cause inflammation and respiratory ailments. Personal allergies may add to the effect of dusts. Some dusts may be hazardous because they are flammable. Dusts of all combustible substances ignite or explode under certain conditions.

■ **Gases and Vapors.** The terms "gas" and "vapor" are often used to mean the same thing, although there is a difference. A gas exists as a gas at ordinary temperature and pressure. A vapor is a gas-like form of a substance that is ordinarily a solid or liquid. Gases and vapors are divided into four groups depending on whether they are poisonous (toxic), asphyxiants, anesthetics, or irritants. Remember that each substance usually has more than one property. For example, it can be anesthetic and also toxic.

☐ **Poisons.** Poisonous or toxic gases and vapors have various effects on the body. They may injure or destroy the visceral organs, the bloodforming system, tissues, or bones. Toxic effects often show up only after a prolonged exposure. The most poisonous gas or vapor is hydrogen sulfide found in crude oil of high sulfur content or tetraethyl lead vapor from leaded gasoline. You must avoid exposure to them at all times, because they can kill you. Victims of hydrogen sulfide may fall unconscious upon exposure and never regain consciousness. Other gases, listed in the order of toxicity, are refrigerants like sulfur dioxide, ammonia, methyl bromide, butane, propane, and the freons. The carbon dioxide used in fire extinguishers is not very toxic, but carbon tetrachloride is toxic, and its effects build up in the body. It can also decompose and form phosgene, a highly toxic gas. For these reasons, carbon tetrachloride is no longer approved for use in extinguishing fires. You should assume that all flammable products are toxic to some degree.

☐ **Asphyxiants.** Simple asphyxiants are gases and vapors that keep the lungs from getting oxygen. In other words, they replace the oxygen that is in the air. Some of them are methane and its related hydrocarbons, hydrogen, and acetylene which is used in welding and flame-cutting. A chemical asphyxiant like carbon monoxide gas acts upon the blood in such a way that it is unable to absorb enough oxygen to sustain the organs of the body. This causes the organs to fail due to a lack of oxygen.

☐ **Anesthetics.** Anesthetic gases and vapors have a narcotic effect, depressing the central nervous system to the point where respiratory failure may occur. All hydrocarbon vapors have this effect. The most narcotic are acetone, the ethers, benzene, naphthas, gasolines, and jet fuels. Others are hydrocarbon derivatives that contain members of the chlorine family. Exposure to burning hydrocarbon vapors can cause tremor of the heart ventricles. Narcotic effects of gasoline and jet fuel increase with aromatic content.

☐ **Irritants.** Irritant gases and vapors inflame the lungs and respiratory tract. They may cause pneumonia and other pulmonary diseases or make the victim more susceptible to them. Most flammable gases and vapors are irritants whether or not they are poisonous or narcotic.

■ **Liquids.**

☐ **Inside the body.** Flammable liquid products are dangerous if you get them in your mouth and may be fatal if you swallow them. If you get petroleum in your eyes or mouth, flush thoroughly and repeatedly with water. (Don't swallow the water.) Then, get medical help at once.

☐ **On the skin.** Flammable liquid petroleum also causes skin contamination. The seriousness of skin contamination ranges widely, depending upon the substance. The most serious effects result from contact with strong acids, alkalis, and rocket fuels. Effects from gasoline, jet fuel, and solvents are less serious, but you must not take them lightly. Fuels, solvents, paints, lacquers, and varnishes act on the skin to dry up natural fats and oils. This leaves the skin harsh, dry, and chapped—a condition known as dermatitis. These unnatural skin openings or lesions increase your chances of infection. If you get petroleum on your skin, wash it off at once with soap and water. If your clothes are soaked with fuel, wet them with water before you take them off. If you don't have any water, temporarily ground yourself by taking hold of a piece of grounded equipment with both hands. Then take off your clothes. This grounding protects you from the danger of a static spark igniting your clothes as you remove them.

■ **Fumes and Mists.** Fumes and mists are described so that you can tell them from gases and vapors. The term "fume" is often used to mean the same thing as gas and vapor. It is more correctly used to mean a solid substance that can turn directly into a vapor without first becoming a liquid and can return to the same solid state later. This process is called sublimation, and it is used to refine such substances as iodine and sulfur. Fumes can also be produced from the lead compounds used in leaded gasolines and paints. Fumes are minute particles of solids. They differ from dusts in that dusts can't return to their solid form. Mists or fogs are minute droplets of liquids and are produced by actions such as atomizing and splashing. They are used in a water-fog nozzle to smother fires and in certain oil-burner nozzles to make fires. You should observe all safety rules when you work where there are fumes or mists. The oil mist from flammable hydraulic fluid escaping under pressure can be a serious hazard.

■ **Oxygen Deficiency.** An oxygen deficiency means that the air you breathe lacks the normal amount of oxygen. This is a health hazard to those who work with flammable products. Normal air contains about 21 percent oxygen. Men working in a concentration of 17 percent will breathe a little faster and deeper. The flame of a safety lamp goes out when the concentration falls to 16.25 percent. Most workers get dizzy and notice a buzzing in the ears at 15 percent. There are very few workers who will not have these symptoms in a concentration of 10 percent. Life is in danger when the concentration falls to about 7 percent. Many flammable vapors are heavier than air. They collect in pits, confined areas, and low spots where they displace the air and cause a lack of oxygen. Tanks that have not been used for some time may lack oxygen due to oxidation. ⓣ

PRECAUTIONS

Vapor Formation and Ignition Sources

The most serious accidents in petroleum storage areas result from the ignition of combustible vapor and air mixtures. Therefore, keep two rules in mind at all times: be sure to control vapor formation and ignition sources. Some ways you can control them are shown in tables 10-2 and 10-3. ⓣ

Transfer and Storage

Be sure you follow safety precautions during transfer and storage operations. Some of these precautions are given in table 10-4. ⓣ

Table 10-2. Controlling vapor formation

Rules	Remarks
Avoid spills	Fill container carefully (whether filling a 5-gallon can, tank vehicle, or storage tank) and avoid overflow.
Use drip pans, catch basins, or absorbent materials (not combustible)	Place where there may be drips or spills.
Inspect frequently for leaks	Leaks may occur in such places as tank seams, joints, piping, valves, or pumps.
Clean up spills or leaks at once	Wash or cover them. (Washing is better in the case of volatile product.) Treat the area as especially hazardous until vapors are gone.
Beware of flammable vapors in empty containers	An empty pipeline or storage tanks, drums, cans, or containers that have held a flammable product are potentially more dangerous than a filled container.
Inspect drums and containers before use	Inspect drums and containers before using. Mark them with some sign of approval if they are fit for use.
Keep containers closed	Empty or full containers for flammable products should be closed.
Open drum bungs carefully	Be very careful when opening drums filled with flammable products if the drums have been subjected to increased temperature or agitation since they were filled. This prevents the sudden release of pressure that can produce a vapor-air mixture that may include some product.
Beware of unventilated space	Vapors can gather in unventilated or confined spaces or pits.
Don't use gasoline for cleaning	Gasoline and carbon tetrachloride (because it is toxic) must not be used for cleaning.
Coordinate with others when ventilating and vapor-freeing	Consult other area operations that could be sources of ignition.

994

Table 10-3. Controlling ignition sources

Rules	Remarks
No smoking	Don't let anyone smoke in the class III supply point.
No matches or cigarette lighters	Don't let anyone bring matches or lighters in the class III supply point.
Don't handle product during electrical storms	Stop loading or unloading flammable products during an electrical storm or when there is a threat of one.
Dispose of waste safely	Use only self-closing metal containers for oil- or paint-soaked waste or rags, and dispose of them each day.
Equipment must be explosionproof	Install only explosionproof electrical equipment and fixtures in hazardous area.
Lights must be explosionproof	Use only explosionproof extension lights or flashlights or electric lanterns with shatterproof lenses when inspecting and repairing in hazardous area.
Inspect electrical apparatus and fixtures often	Correct immediately any condition that may cause sparking, arcing, or heating.
Take precautions when working on electrical equipment	Open switches and pull fuses before you start to work.
Inspect grounding system	Inspect ground wires monthly. Test grounding system annually or when it suffers mechanical damage. Replace or repair faulty equipment.
Coordinate hot work with other operations	Coordinate all hot work in the vicinity of tank-ventilating and vapor-freeing operations so that they do not become hazardous to each other.

1018

Table 10-4. Safety rules for transferring and storing product

Rules	Remarks
Bond and ground equipment	For all petroleum operations, always bond and ground equipment.
Avoid overhead filling	If you can't avoid overhead filling, put the end of the filling line inside the tank so that the fuel will be disturbed as little as possible.
Use walkways	Always use walkways to cross tank firewalls. Always use walkways as much as possible.
Ventilate and clean vehicles and containers	Collapsible tanks, railway tank cars, and tank vehicles must be cleaned and ventilated as prescribed in FM 10-20.
Observe safety rules when fueling aircraft	Observe all safety precautions prescribed in FM 10-68.
Observe safety rules when operating, loading, or transferring product	Observe all safety precautions prescribed in TM 10-1113.

FIREFIGHTING

Firefighting Plan

The nature of tactical class III supply point operations requires that you place additional emphasis on fire control and prevention. Class III supply points are usually in isolated field positions far from any organized fire departments or engineer firefighting teams. This means that the ability to extinguish a fire, if it starts, rests with the personnel at the supply point and is the direct responsibility of those supervising it. Therefore, develop a fire plan before you start operating the class III supply point. If you have a fire plan, you can react quickly and effectively if a fire starts. Make the plan as comprehensive as possible; that is, consider all areas of the class III supply point. But remember, if there is a fire department in your area of operation, notify it immediately when a fire starts. The following will help you plan.

■ **Placement of Fire Extinguishers.** The only way to fight a petroleum fire at a class III supply point is with portable carbon dioxide fire extinguishers. Place one at each pump, collapsible tank, receiving and issuing point, can and drum cleaning and filling area, and packaged product storage area. Place other extinguishers where personnel can get to them and get to any part of the supply point quickly. Show the location of all your fire extinguishers on a map of the supply point so that personnel can find them easily. Place a map at each checkpoint and at several locations in the area of operation. If you don't have a natural supply of water, make sure the installation has enough water tanks to supply water to control fires.

■ **Personnel.** Assign two people to each fire extinguisher in the supply point. Make sure they and all workers at the supply point know how to use them. Also, form a firefighting team you can send quickly to any area in case of fire. There should be about five men on the team.

■ **Evacuation Routes.** Set up evacuation routes for vehicles and personnel. If a fire breaks out, all vehicles must be quickly removed from the area. Personnel who are not fighting the fire must also leave at once. Evacuation routes should be the fastest means of exit from the supply point. These routes should also be illustrated on the maps showing the placement of fire extinguishers.

■ **Fire Drills.** Use fire drills to train personnel to react quickly in case of fire. Fire drills should be as realistic as possible and evacuation routes should be used and fire extinguishers manned. Conduct a fire drill at least once a month or when there is a personnel turnover. ⊙

Principles of Extinguishing Fires

There are three elements to consider when putting out a petroleum fire. They are the control of fuel, heat, and air. How you control an element, or combination of elements, will depend on your situation.

■ **Control of Fuel.** First shut off the flow of fuel if you can. The fire may be in a burning tank, a damaged or leaking product line or pump, or a broken gasline. It is hard to get to a fire in a broken fuel line with any kind of extinguisher. Plug the break if you can. Then, stop the flow at the nearest valve, and use foam on burning pools of the fuel. Do not use water and foam together because water will destroy the effectiveness of the foam and further spread the fuel. In the case of burning gas, it may be wise not to put out the flame before you shut off the flow. The danger of escaping gas, and a possible explosion, could be as great as the danger of combustion. It may be better to direct your initial efforts toward controlling the blaze until you can stop the flow of gas.

■ **Control of Heat.** Heat is transmitted by radiation, conduction, and convection. Heat radiates in all directions, and it is a hazard to storage tanks near a blaze. Heat is conducted through a solid or liquid substance. Convection takes place as heated air rises from the fire and circulates. This brings heat to all combustibles within reach. The best way to reduce heat and vapor is to use water in streams, spray, or fog. Usually, the best way to protect a storage tank that is near a fire is to cool it with water.

■ **Control of air.** You can't remove all air in the area of a fire, but you can dilute the air, or smother the fire, or both. To dilute the air, you reduce the percentage of oxygen to the point where it will no longer support combustion. To smother the fire, you cut off all air at the surface of combustion.

☐ **Dilute.** You can dilute the air by using carbon dioxide, water fog, mist, or steam. This does not take place all at once; you should continue until the fire goes out. Carbon dioxide is a dry, noncorrosive gas that does not act when in contact with most substances. It does not conduct electricity and is not a health hazard except in great concentration. Water fog dilutes the air and also helps protect personnel because it screens the heat and washes fumes and smoke from the air. Live steam also does a good job of diluting, but it also increases the heat in the area of the fire. Steam does a better job of smothering when applied to the top of a storage tank.

☐ **Smother.** Foam is one of the best ways to blanket and smother a petroleum fire. To do this, spread a tight covering of foam on the burning surface to cut off all air. You can spread the blanket easily on the top of a burning tank. Foam tends to break down in fire, so continue to apply foam long enough and fast enough to let the tank cool below the temperature where the fuel can ignite again. The depth of foam you need may vary from a few inches for a small tank to several feet for a large tank. It is common practice to provide a source that can furnish enough foam to put out a fire in the largest single area protected rather than several small fires at one time. You can smother small fires with sand, wet burlap, or a blanket.

Classes of Fires

Underwriters Laboratories, Inc., groups fires into classes A, B, and C. The National Fire Protection Association groups them in classes A, B, C, and D. The four classes are as follows:

■ **Class A.** These are fires that break out in combustibles such as wood, brush, grass, and rubbish. The cooling and quenching action of water makes it the best agent for putting out class A fires.

■ **Class B.** These are fires that break out in flammable liquids such as gasoline and other fuels, solvents, lubricants, paints, and similar substances that leave no embers. A smothering or diluting agent is best for putting out class B fires.

■ **Class C.** These are fires that involve live electrical equipment such as motors, switches, and transformers. A smothering agent is best for putting out class C fire, but the agent must not be a conductor of electricity.

■ **Class D.** These are fires in combustible metals such as titanium, zirconium, sodium, and potassium. A smothering agent is best for putting out class D fires.

Fire Extinguishers

Install a fire extinguisher, or a sign indicating the location of the closest extinguisher, at all petroleum storage, handling, and dispensing areas. The Army uses both portable hand extinguishers (table 10-5) and wheeled units. Portable hand extinguishers, except pump-tank ones, are available in various sizes and in all types discussed below. The agent used in the pump-tank unit is water or an antifreeze solution, usually calcium chloride with corrosion inhibitors. Portable fire extinguishers are effective only in the earliest stages of fires. For this reason, they are called first aid appliances. Wheeled units are available in all types discussed below. They are more flexible because they have longer hoses and greater capacities.

Table 10-5. Types of Portable Fire Extinguishers

Type	Agent	Effect	Use	Expellant	Electrical conductor	Subject to freezing
Soda-acid	Water	Cooling and quenching	Class A	CO2 gas from chemical reaction	Yes	Yes
Antifreeze	Calcium chloride	Cooling and quenching	Class A	Stored pressure, cartridge, or chemicals	Yes	No
Loaded-stream	Alkali-metal salts	Cooling, quenching, and retarding	Class A Class B	Cartridge or chemicals	Yes	No
Foam	Foam	Diluting or smothering	Class A Class B	Chemicals	Yes	Yes
Carbon dioxide	Gas and dry ice	Diluting or smothering	Class B Class C	Self-contained pressure	No	No
Dry-chemical	Treated sodium bicarbonate	Smothering	Class B Class C	Gas or cartridge	No	No

■ Types.

☐ **Soda-acid.** The soda-acid extinguisher is the most common water-solution type that uses gas pressure as an expellant. The chemicals in the extinguisher are sodium bicarbonate (baking soda) and sulfuric acid. The bicarbonate is in water-solution form in the extinguisher, and the acid is contained in a loosely stoppered glass bottle. When the extinguisher is inverted, chemical reaction produces carbon dioxide that builds up pressure and expels the water. Use this type of extinguisher for class A fires only.

☐ **Antifreeze.** The antifreeze-solution unit is charged with a calcium chloride solution. The expellant is gas from carbon dioxide cartridges or from chemical reaction. The extinguisher is operated by inverting it and bumping it on the floor or by squeezing a valve lever. Use this type of extinguisher for class A fires.

☐ **Loaded-stream.** The loaded-stream extinguisher is charged with an alkali-metal salt solution and other salts. Potassium salts are a part of the charge.

The way the agent works on a fire differs according to the class of fire. It puts out class A fires suddenly, and helps keep them from starting again. The way it works on small class B fires is not clear. The agent produces no smothering vapor, but there seems to be a chemical reaction that tends to hold down combustion.

☐ **Foam.** The foam extinguisher is usually charged with a water solution of sodium bicarbonate with a stabilizing agent. A small, separate container holds an aluminum sulfate solution. When the unit is inverted, mixture of the two solutions produces carbon dioxide gas. Pressure builds up and expels the liquid in the form of tiny bubbles toughened by the stabilizing agent. A 2 1/2-gallon extinguisher makes 18 to 20 gallons of foam. Use this type of extinguisher for class A and class B fires.

☐ **Carbon dioxide.** The carbon dioxide (CO2) extinguisher comes in many sizes. The charge of liquid carbon dioxide under 800 to 900 psi pressure is released by means of a hand valve at the top of the unit. A tube runs from the top to bottom of the unit so that only liquid carbon dioxide is released until about 80 percent has been used. Gaseous carbon dioxide then flows until the charge is exhausted. The charge flows in a high-velocity stream, and a horn, or flaring nozzle, is provided to keep it from being diluted. When the charge is released and enters the horn, the chilling due to expansion turns about 30 percent into dry ice or snow. Carbon dioxide works well to dilute air in class B fires. It works well on class C fires also, because it's not a conductor.

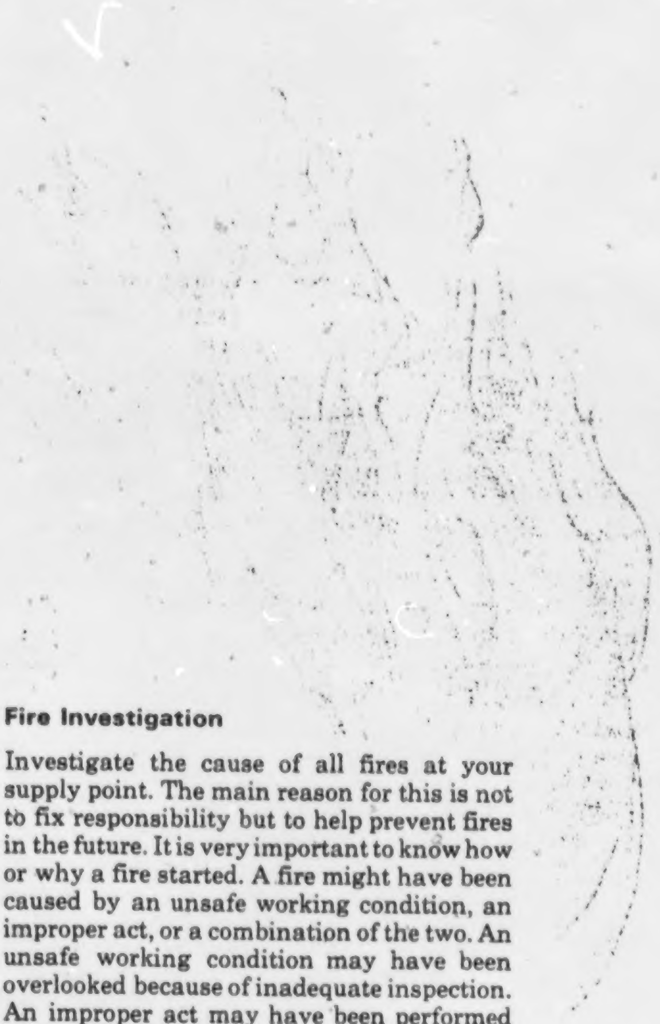
☐ **Dry-chemical.** The dry-chemical extinguisher is available in a wide range of sizes. The agent is chiefly sodium bicarbonate powder with additives to produce water repellency and free flow. The expellant is carbon dioxide, nitrogen, or compressed air. The extinguisher puts out the fire by smothering it. It works well on class B and class C fires.

☐ **Water.** You can sometimes put out an oil fire with water. Solid water streams, sprays of water, and water fog all have their proper application. Trained personnel should decide when, where, and how to apply water.

■ **Use and Maintenance.** The rules for use and upkeep of fire extinguishers is given in table 10-6.

Table 10-6. Use and upkeep of fire extinguishers

Use and maintenance rules
1. Know **HOW** to operate the fire extinguisher.
2. Know **WHICH** extinguisher to use for each type of fire.
3. **CHECK** monthly to make sure extinguishers are in place.
4. **INSPECT** monthly to see if extinguishers have been damaged.
5. **RECHARGE** extinguishers immediately after use.
6. Have trained personnel **EXAMINE** extinguishers at least twice a year to make sure they are in good working condition. The inspection date and initials or name of the inspector must be recorded on a tag, and the tag must be attached to the extinguisher.
7. **TEST** all pressure extinguishers hydrostatically every 5 to 12 years (this depends on the extinguisher).
8. **FOLLOW MANUFACTURERS INSTRUCTIONS** exactly for charging, maintaining, and using the extinguisher. **USE** TM's 5-687 and 5-315 as guides.



Fire Investigation

Investigate the cause of all fires at your supply point. The main reason for this is not to fix responsibility but to help prevent fires in the future. It is very important to know how or why a fire started. A fire might have been caused by an unsafe working condition, an improper act, or a combination of the two. An unsafe working condition may have been overlooked because of inadequate inspection. An improper act may have been performed which good supervision could have corrected on the spot.

1001

TM 5-343

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

MILITARY PETROLEUM PIPELINE SYSTEMS

This copy is a reprint which includes current pages from Change 1.

HEADQUARTERS, DEPARTMENT OF THE ARMY
FEBRUARY 1969

1002

NOTE: Only the materials from TM 5-343 on the subject of manifolds have been included here as required in the Program of Instruction.

2-9. Ship-To-Shore and Dockside Tanker Unloading Facilities

In an oversea theater a military petroleum bulk supply and distribution system begins at a port of debarkation where fuel is unloaded from tankers. The use of existing wharves simplifies the job of tanker unloading. When wharves are not available, other means have to be provided. In protected waters a jetty is extended offshore (up to 1,000 feet) with a 40- by 70-foot wharf, and the tanker is berthed alongside. From the wharf the pipeline is carried to shore over the jetty. Where the tanker berth must be located in unprotected waters, ship moorings are provided at which the tanker may lay with its bow into the prevailing wind or current. One or more submarine pipelines are then extended from the shore to the tanker mooring. These submarine pipelines must be long enough to reach water which is safe for mooring. Depending upon the tide range or beach gradient, this length may range from 1/2 to 5 miles. The submarine pipeline is connected to the terminal trunkline at the shore end. At the sea end, it is provided with a permanently attached flanged discharge hose (usually 2 1/2 times the water depth). The free end of the hose is closed with a plug valve and a blind flange or with a blind flange only, and is attached to a marker buoy with a lifting chain to facilitate making the hookup with the tanker. Unloading facilities should have the capacity to unload the largest tanker in considerably less than 24 hours. When greater discharge capacity is needed or two or more tankers are to be handled simultaneously, additional lines are added. These facilities are arranged so that fuel also can be loaded from the tank farm to coastal tankers and barges through the use of tank farm transfer pumps and through the use of by-passes around check valves.

2-10. Marine-Terminal Storage Installations

From the tanker unloading facilities (submarine, jetty, or dockside), the fuel is pumped forward to terminal storage facilities. These facilities are composed of a single 200,000 barrel tank farm, or 400,000 barrel to 1,000,000 barrel major tank farm complexes (drawing 12-09, TM 5-302). All storage tanks in a farm or major complex are interconnected by pipelines manifolded so that one to four petroleum products can be moved into, out of, and between tanks in accordance with scheduled use requirements.

2-11. Trunk and Branch Pipelines

From the ship-to-shore or dockside unloading line the fuel flows to the terminal storage facility through a 12-inch main trunkline. Normally, only one trunk pipeline is required to supply a 200,000 barrel marine terminal; two lines and sometimes more are provided for terminals having a capacity of 400,000 barrels or more. From the marine terminal, the trunkline is extended forward, normally reduced in size, to follow the course of battle. Branch lines may be connected to the trunkline to serve airfields and other large consumers. These branch pipelines are constructed with pipe sizes dependent on throughput requirements. The pipehead terminal supporting a field army may move forward by bounds along with the army supply point as often as every 2 or 3 days. Portable storage serving the advance is fed by the pipeline and is manifolded together by hose for the normal supply of the pipehead dispensing facility.

2-12. Pump Units

Pumps perform many important functions in a military pipeline system. In effect, they act as the heart of the pipeline system in regulating distribution. The same type pump, by different arrangement of its manifold, may be employed to perform more than one function.

a. Station Pumps. The type of pump employed for pipeline pump stations is determined by the size of the pipeline. Lines constructed of 4- and 6-inch lines call for 4-inch, four-stage pumping units; 8- and 12-inch lines call for 6-inch, two-stage or 6-inch, multistage pumping units.

b. Booster Pumps. Tankers usually have two or more pumps of sufficient capacity for offloading to the terminal storage tanks. However, shore booster pumps will be necessary where there is a long ship-to-shore pipeline or a long line from the dock to storage, or where the terminal storage is considerably above sea level. The 6-inch, single-stage, selfpriming, pumping unit can be employed with the 8-12 inch lines from the tankers.

c. Flood Pumps. Flood (or feeder) pumps normally are installed to supply the required

1004

suction pressure between tank farm installations and main-line (trunk) pumping stations, or to feed fuel through short branch lines to dispensing tankage installations.

d. Transfer and Tank Pumps. Transfer and tank pumps are connected with the switching manifold of tank farm installations to move large volumes of petroleum products into, out of, and within the tank farm. The purpose of such pumping may be to transfer fuel from damaged or leaking tanks to sound ones, to consolidate fuel from partly empty tanks, to empty tanks so as to provide space for new fuel shipments which should not be mixed with existing supplies before testing, or to blend different batches of fuel to uniform specifications. Depending on the elevation and other site conditions, tank pumps may be used to relay tank contents to dispensing tankage.

e. Loading Pumps. Loading pumps normally are required to relay petroleum products from tankage to the dispensing outlets, except when the required rate of flow is supplied by a gravity system. They usually are used for tank-car and tank-truck filling installations.

2-13. Intermediate and Pipehead Storage Installations

a. As is the case for marine-terminal storage, tank farms provide for intermediate and pipehead storage requirements (fig. 2-2). These include:

(1) Station fuel supply storage consisting of 100-barrel or larger tank.

(2) District-terminal tankage which holds as much of the reserve supply as is required for pipeline supply of fuel to the using units (these tank farms may also function as regulating tankage).

(3) Airfield storage tankage, usually supplied by a branch line from the trunk pipeline and located within 1 mile of the airfield dispensing points.

(4) The portable pipehead usually consisting of collapsible envelope type tanks.

b. Normally, all intermediate and pipehead storage installations should provide for reserve supplies of each type (usually four) of fuel to be carried through the pipeline or through dispensing lines fed by the tank farms.

2-14. Bulk Reduction Dispensing Facilities

Bulk reduction dispensing facilities are an integral part of tank farms from which bulk fuel is transferred from the pipeline system to other means of transportation or where it is packaged or delivered to the using vehicles. Army bulk reduction points may include facilities for transferring bulk supply to tank trucks and tank cars and for dispensing fuels; filling stations may be established near depots, supply points, railheads, bivouac areas, rest camps, tank farms, and similar installations (FM 10-17). Tanktruck loading installations may be installed at pipeheads or class III facilities for further bulk shipment before the fuel is broken down into containers. Air Force operated, on-base dispensing systems consist of facilities beyond the point where Army responsibility for Air Force fuel supply ends.

2-15. Communications Circuits

a. An exclusive system of communications is essential for the efficient construction, operation, and maintenance of military pipelines. The communications system must be separate, continuous, and dependable. Figure 2-3 illustrates a typical pipeline communications net which includes telephone, teletype, and radio communications circuits, and provides for dispatcher, interterminal, and interservice. Signal commands are responsible for the planning, construction, and major maintenance, and furnish the troops and equipment required; quartermaster units operate.

1006

temperature variances. Using a block and tackle to close small gaps is acceptable, if inspection indicates this can be done without the danger of creating *other* gaps from excessive strain on adjacent couplings, either while repairs are being made, or after the system is pressurized.

3–9. Pumps

Data on the capacity and operating characteristics of pumps, sufficient for pipeline planning, are included in this manual. Instructions on operation and maintenance are included in manufacturers' manuals which are packaged with each pump. Three sizes of centrifugal pumping units are currently standard for military pipeline service—the 4-inch, four-stage pumping unit; the 6-inch, two-stage pumping unit; and the 6-inch, single-stage, self-priming pumping unit. A 6-inch, multistage, diesel engine driven unit has been standardized and is scheduled to enter the system shortly.

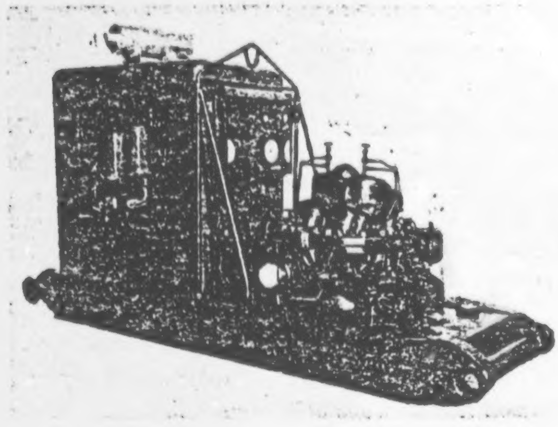


Figure 3–14. A 4-inch, four-stage pumping unit.

a. Four-Inch, Four-Stage Pumping Unit. The 4-inch, four-stage pumping unit consists of a gasoline-engine power unit and a four-stage centrifugal pump (fig. 3–14 and 3–15). This pumping unit is designed for use with 4- and 6-inch pipelines. However, it will be replaced by the six-inch multistage diesel driven pump in six-inch pipelines. Operating at 1,800 revolutions per minute (rpm), the unit will pump 785 BPH of 0.725 specific gravity gasoline against a 463-foot dynamic head (Glossary). Operating characteristics are found in figure 3–16. The powerplant and pump are briefly described below.

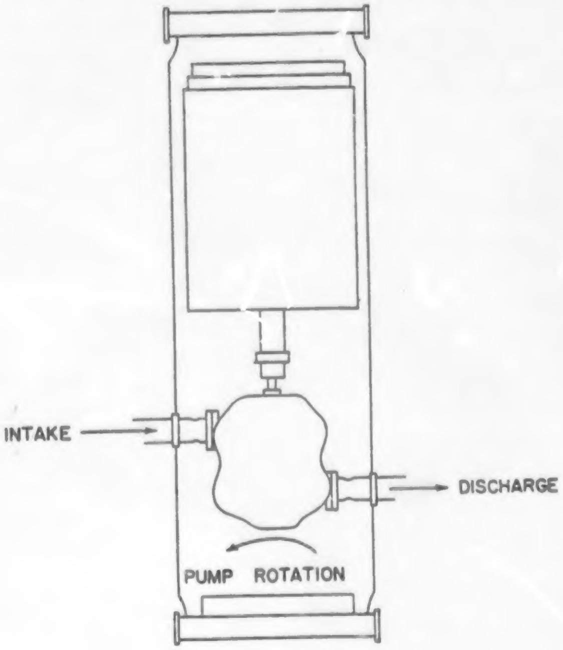


Figure 3–15. Plan showing intake, discharge, and rotation of a 4-inch, four-stage pumping unit.

Sandtraps are, in effect, sediment chambers which collect dirt, scale, sludge, and floating debris pumped through the pipelines or that accumulated during line cleaning. They are installed in pairs on the suction side of each pumping station. A sandtrap consists of a 14-inch drumlike steel barrel made up in three sections as illustrated in figure 3-31. The removable middle section is easily rolled aside for cleaning, and the 6-inch grooved nipples welded to the inlet and outlet sections facilitate coupling into the pump station manifold. The outlet section is fitted with a strainer-screen for the removal of particles not trapped by sedimentation. Use of 6 inch x 4 inch or 8 inch x 6 inch reducers makes the sandtrap adaptable to any size pumping station facility.

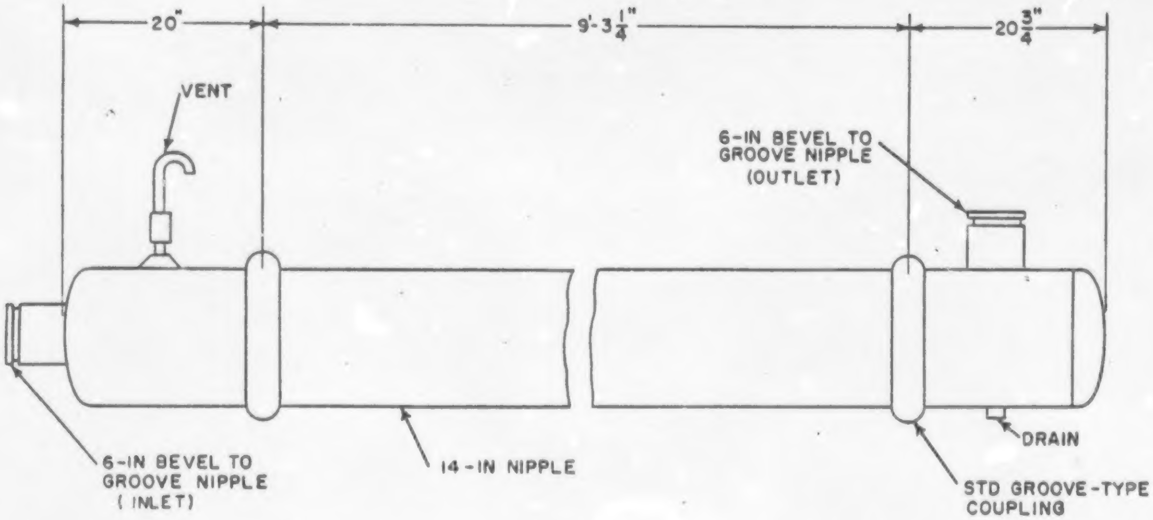
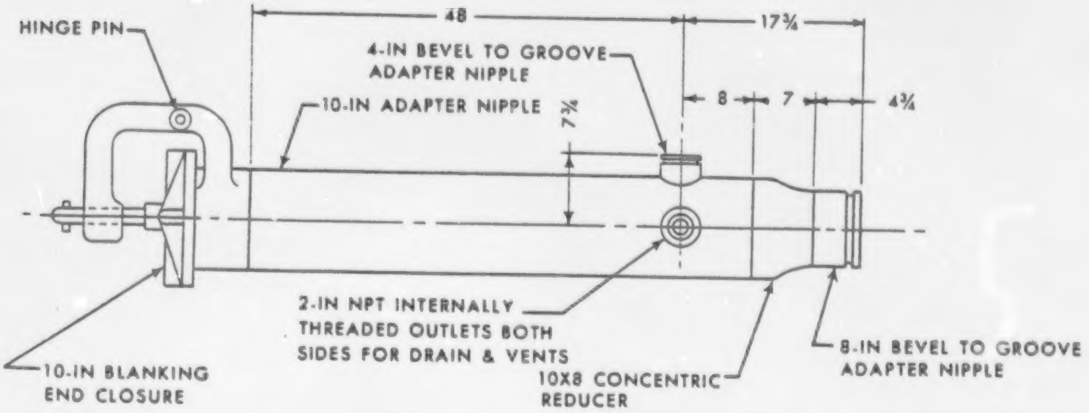

20"
9'-3 1/4"
20 3/4"
VENT
6-IN BEVEL TO GROOVE NIPPLE (OUTLET)
DRAIN
6-IN BEVEL TO GROOVE NIPPLE (INLET)
14-IN NIPPLE
STD GROOVE-TYPE COUPLING

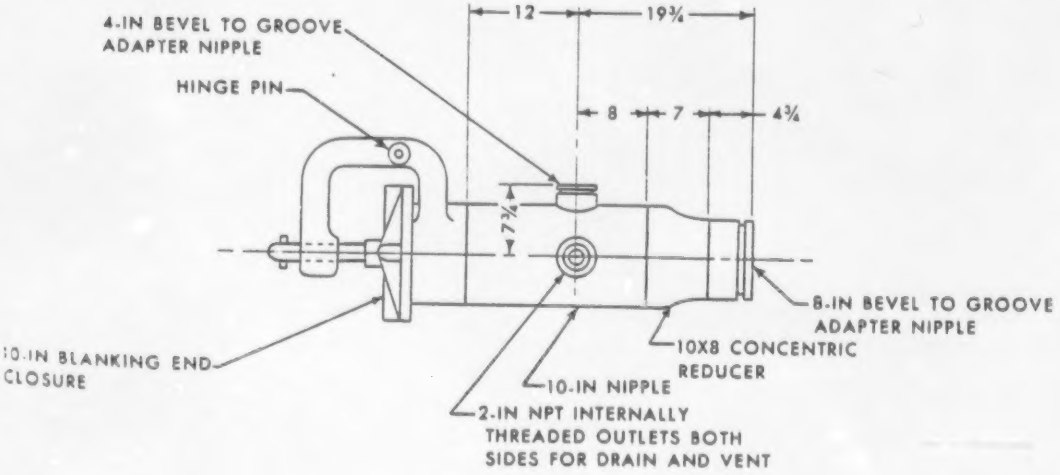
Figure 3-31. Detail of a pipeline sandtrap assembly.

3-12. Cleaner Barrels

Steel cleaner barrels (scraper traps) are included in 6- and 8-inch trunk-pipeline pump station manifolds to send and receive fluid-propelled pipeline cleaners used in cleaning the system. Details of an 8-inch incoming and outgoing cleaner barrel are illustrated in figure 3-32. Notice that the pipeline end connection is grooved to accommodate the standard split-ring grooved-type coupling. The blanking end closure is hinged to permit lateral displacement of the blanking cap and provides unobstructed access to the barrel proper for insertion or removal of the cleaner. The 6-inch cleaner barrels differ only in size and in the fact that the blanking cap is not hinged but is secured by the standard coupling.


48
17¾
HINGE PIN
4-IN BEVEL TO GROOVE ADAPTER NIPPLE
10-IN ADAPTER NIPPLE
7¾
8
7
4¾
2-IN NPT INTERNALLY THREADED OUTLETS BOTH SIDES FOR DRAIN & VENTS
10-IN BLANKING END CLOSURE
10X8 CONCENTRIC REDUCER
8-IN BEVEL TO GROOVE ADAPTER NIPPLE

(A) INCOMING BARREL


12
19¾
4-IN BEVEL TO GROOVE ADAPTER NIPPLE
HINGE PIN
8
7
4¾
7¾
8-IN BEVEL TO GROOVE ADAPTER NIPPLE
10X8 CONCENTRIC REDUCER
10-IN BLANKING END CLOSURE
10-IN NIPPLE
2-IN NPT INTERNALLY THREADED OUTLETS BOTH SIDES FOR DRAIN AND VENT

(B) OUTGOING BARREL

Figure 3-32. Detail of 8-inch pipeline cleaner barrels.

3-19. Pumps and Manifolds

Depending on their functional operation, pump and manifold facilities provide for design capacities of 355, 700, 785, 700-1,400, 1,355, 1,400, 2,000-2,500, 2,800 and 7,000 BPH. The three standard pumps described in paragraph 3-9 are used singly, in pairs, or in series of parallel hookups of three and four pump unit combinations, to deliver these quantities of petroleum products. Table 3-6 lists the different types of pump units employed in a bulk supply and distribution system. The pump and manifold facilities used for the various design capacities are identified by their respective code numbers. The numeral and capital letter in parentheses indicate the number of pump units and the type of pump used to meet capacity requirements. This table, together with the following descriptions of pump and manifold facilities, points up the wide interchangeability of the three standard pumps.

a. Loading-Pump and Manifold (Dwg 12-31). A choice of two facilities is provided for the construction of loading facilities at all bulk-reduction installations (para 2-14). The two facilities have design capacities of 700 to 1,500 BPH, 6-inch line (code 123104) and 2,000 to 2,500 BPH, 8-inch line (code 123105). Each unit consists of standard pipe, couplings, gaskets, nipples, fittings, valve sections, pressure-relief valve assemblies, 600-gpm filter/separators, and sediment strainers that are required to manifold the loading pump with the pipeline, the tank farm switching manifold, and the loading facility (tank car, tank truck, class III pipehead, etc.). The single-stage pumping unit (para 3-9*c*) is provided for the 700 to 1,400 bph installation, and the two-stage pumping unit is provided for the 2,000 to 2,500 BPH installation.

b. Pipeline Pumping Stations (Dwg 12-52). A choice of three facilities is provided for the installation of main line pumping stations (par. 2-12a).

Table 3-6. Pumps and Manifolds for Various Types of EFCS Pump Unit Facilities

Pumps and manifolds	Design capacities in barrels per hour (BPH)								
	355	700	785	700-1400	1355	1400	2000-2500	2800	7000
Loading (Dwg 12-31)				123104 (1,C)			123105 (1,B)		
Pipeline (Dwg 12-52)	125201 (2,A)		125202 (4,A)		125203 (4,B)				
Booster (Dwg 12-31)						123101 (2,B)		123102 (4,B)	123103 (4,B)
Flood (Dwg 12-32)			123211 (2,C)		123212 123213 (2,C)				
Tank (Dwg 12-32)		123221 (1,C)				123222 (1,C)		123223 (1,B)	
Transfer (Dwg 12-33)		123301 (1,C)				123302 (1,C)		123303 (1,B)	

Notes. 1. The pump and manifold facilities are identified by the respective EFCS code (TM 5-303).

2. Numerals in parentheses indicate the number of pumping units and the capital letter identifies the pumping unit, namely: A. four-inch, 4-stage; B. six-inch, 2-stage; and C. six-inch, single-stage, self-priming. (See para 3-9).

3. Drawing numbers refer to TM-302

Each facility is a complete unit and provides the required number of pumping units with manifolding, valves, sandtraps, and pipe cleaner stations necessary to connect the pumping station into 4-inch (code 125201) 355 BPH design capacity, 6-inch (code 125202) 785 BPH design capacity, and 8-inch (code 125203) 1,355 BPH design capacity. From table 6, it will be noticed that the two four-stage pumps provide the 355 BPH capacity, four four-stage pumps provide the 785 BPH capacity, and four two-stage pumps provide the 1,355 BPH capacity. Pipeline pumping stations require a separate fuel supply facility to complete their installation.

c. Booster Stations (Dwg 12-31). There are three pump and manifold facilities in this group. All are designed for the installation of booster stations required to push petroleum products unloaded from tankers on to the marine-terminal tank farm complex (para 2-12*b*). Each facility includes standard line pipe, couplings, nipples, valve sections, and fittings together with the required number of pumps for installation of booster stations for 6- or 8-inch, 8-inch, and 12-inch pipelines. Manifolds may be connected in parallel or series, and the pump stages for the two-stage pumps employed for booster stations may be connected in series or parallel. Two two-stage pumps in series with manifold in series installed in 6- or 8-inch lines (code 123101) provide a flow rate of 1,400 BPH. Four two-stage pumps in series with manifold in parallel installed in 8-inch lines (code 123102) provide a flow rate of 2,800 BPH. Four two-stage pumps in parallel with manifold in parallel installed in 12-inch lines (code 123103) provide a flow rate of 7,000 BPH. Booster stations require a separate fuel supply facility to complete their installation.

d. Flood Pump and Manifold (Dwg 12-32). Three pipeline flood pump and manifold facilities provide all the essential materials for assembly of manifolds and pumps for 6-inch, 785 BPH (code 123211); 8-inch, 1355 BPH (code 123212); and 12-inch, 1355 BPH (code 123213) flood (feeder) pump stations (para 2-12*c*). Two single-stage, self-priming, pumping units (para 3-9*c*) are used with each size pipeline.

e. Tank Pump and Manifold (Dwg 12-32). In effect, tank pump stations are supplemental to transfer pump facilities (para 2-12*d*). In general, tank pump and manifold facilities are installed in the pipeline of every other tank of a tank farm connecting with its switching manifold. When operated with the transfer pump, or separately, they help provide for the simultaneous movement of products within the tank farm or to dispensing facilities served by the tank farm (Dwg 12-07). In this group, three facilities provide all the materials for assembly of the pumping station complete with manifold. The single-stage, self-priming pump (para 3-9*c*) is employed with both the 6-inch (code 123221) 700 BPH manifold and the 8-inch (code 123222) 1,400 BPH manifold; the two-stage pump (para 3-9*b*) is employed with the 12-inch (code 123223) 2,800 BPH manifold.

f. Transfer Pump and Manifold (Dwg 12-33). Transfer pump units and tank pump units differ only in their manifolding. From table 3-6, it will be noted that the design capacities are the same. Also, the same pumps are employed with either installation; a choice of three facilities, code 123301 through 123303, is available for the installation of pump units with manifold providing the required rates of flow of 700, 1,400, or 2,800 BPH.

3-20. Pump Station Fuel Supply
(Dwg 12-42)

All pumping facilities in a military pipeline system, except pipeline (mainline) pumping and booster stations, normally are close enough to tankage to draw motor gasoline for operation of their powerplant engines. The pump station fuel supply facility is designed to provide all essential materials for manifolding a fuel storage tank to the engine fuel tanks of the pumping units at a pipeline or booster stations. These fuel supply facilities are usually installed at isolated locations which may be several miles from any storage installation. Two sizes of facilities are available; one for two-unit (code 124201) pumping stations and the other for four-unit (code 124202) pumping stations. Each facility consists of 4-inch pipe (grooved tubing and pipe) sections, couplings, gaskets, and valves for connecting one 100-barrel capacity (or larger) bolted steel tank with the pump manifold; and 3/4-inch pipe, fittings, and valves for assembly of the engine fuel supply manifold. The tank is not included with either facility and must be obtained separately (class IV, supply). The tank size will depend on consumption rates and planned resupply intervals.

3-21. Switching Manifold
(Dwg 12-32)

A switching manifold is an assembly of pipe, fittings, and valves used for controlling the flow of petroleum products into, out of, and within a tank farm or for manifolding two to four groups of tanks (tank farm complex) into the pipeline system. This facility may be used singly or in multiples, with or without tank pump or transfer pump manifold facilities (para 2-12*d*). From an operating standpoint the control switching manifold for a tank farm complex is one of the most critical installations in the entire bulk sup-

3-32. Tank Farm Complex
(Dwg 12-08)

Tank farm complex installations are provided for four logistical capacities: 400,000 barrels; 600,000 barrels; 800,000 barrels; and 1,000,000 barrels. The first three complexes are made up of two, three, and four identical 200,000-barrel tank farm installations respectively; the 1,000,000-barrel complex is made up of four identical 250,000-barrel tank farm installations. The tank farms in each complex are spaced a minimum distance of 4 miles. Each tank farm is supplied by two branch lines manifolded to two incoming trunk pipelines. Because of the distance between tank farms, booster facilities are added in each branch line to provide the line pressures essential for adequate fuel flow to the tank farm switching manifold. Table 3-9 lists the facilities employed and the quantities required for each standard tank farm complex installation.

Table 3-9. Standard Tank Farm Complex Installations (Dwg 12-08)

Facility/Installation	400,000 Barrel			600,000 Barrel		800,000 Barrel		1,000,000 Barrel	
	QC-1.036 6" line	QC-1.046 8" line	QC-1.056 12" line	QC-2.046 8" line	QC-2.056 12" line	QC-3.046 8" line	QC-3.056 12" line	QC-4.046 8" line	QC-4.096 12" line
Tank, POL 250 BBL Facility w/4" line Dwg 12-34	2	2	2	3	3	6	6	6	6
Tank Farm Installation:									
200,000 BBL	2	2	2	3	3	4	4		
250,000 BBL Dwg 12-07								4	4
Switching Manifold Facility Dwg 12-32	1	1	1	1	1	1	1	1	1
Booster Station Facility:									
1400 BBL	4								
2800 BBL		8		12		24		24	
7000 BBL Dwg 12-31			8		12		24		24
Pump Sta Fuel Supply Facility:									
2 unit	8	8							
4 unit Dwg 12-42			8	6	12	12	24	12	24
Pipe & Accessories Facility Tubing - one mile	8	8	8	18	18	18	24	24	24
Adm & Operation Bldg Facility Hq & Unit Supply 20' x 40' Dwg 61-11	1	1	1	2	2	3	3	3	3

Figures in code squares denote quantities of unit facilities or major installations which are combined to complete the type and size of tank farm storage complex installations.

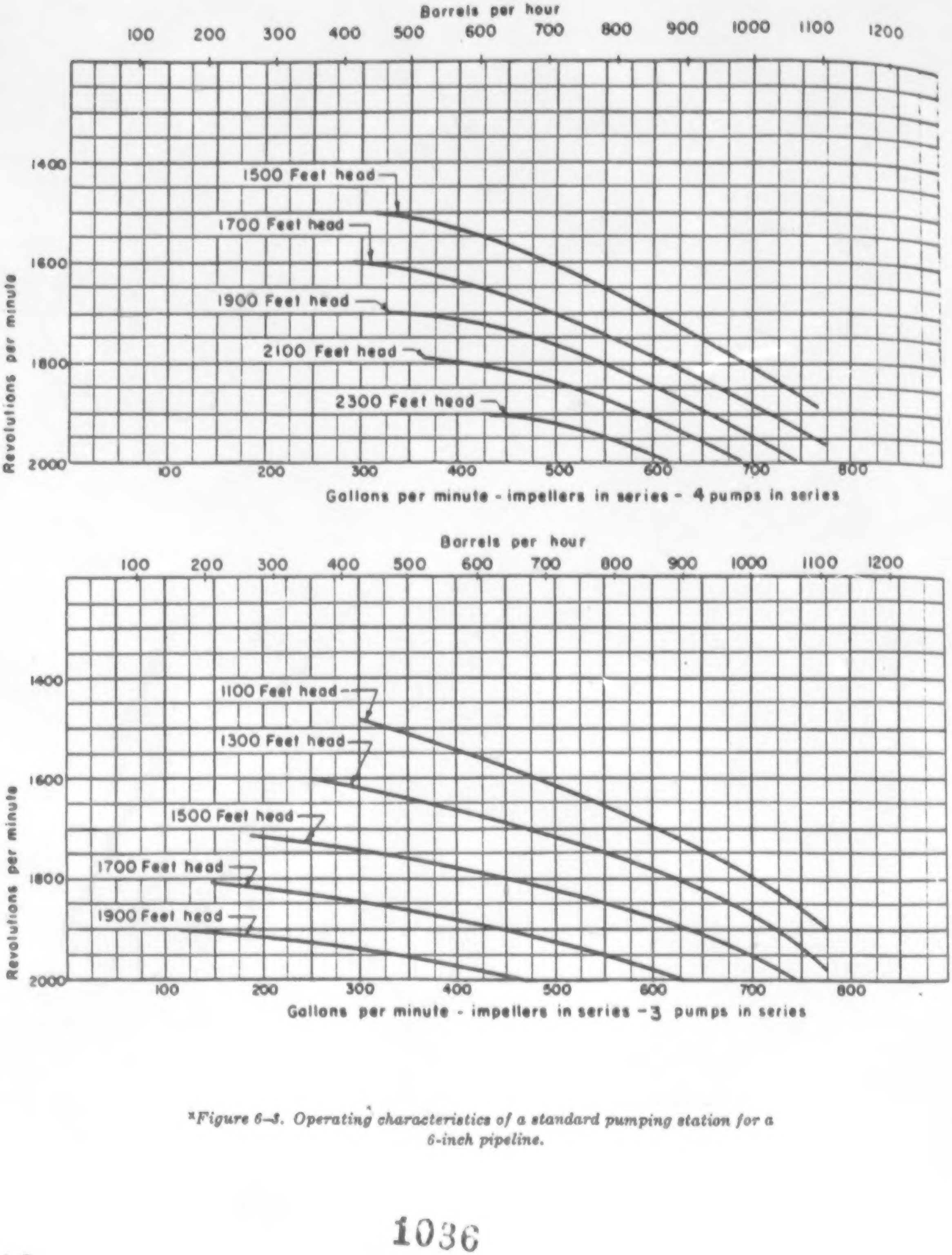


**Figure 6-3. Operating characteristics of a standard pumping station for a 6-inch pipeline.*

a. Use of Larger Pipe. If the problem is anticipated and material is available, the use of larger pipe to reduce friction loss will save time and work in that the line will not have to be laid twice. A typical problem involving the use of a larger pipe size follows:

(1) *Problem.* The friction loss in a 1,786-foot section of 6 5/8-inch tubing must be reduced to a maximum allowable head of 18 feet under maximum emergency-flow conditions. Maximum emergency rate of flow is 928 BPH. Determine the maximum length of 8 5/8-inch tubing required to reduce the head loss to 18 feet.

(2) *Principles and equations.* Solution of this problem is based on the following principle: the total head or pressure loss in a section of pipeline, consisting of two sizes of pipe in series, is equal to the sum of the friction losses for each size and length of pipe. This rule is expressed in the simple equation:

$$F = L_1\ (f_1) + L_2\ (f_2)$$

When:

F = the total friction loss in feet of head,

L = the length of pipe,

f = the friction loss in feet of head per 1,000 feet for the specific type of pipe.

(3) *Solution.* Under the conditions of the problem, the total friction loss must be no greater than the maximum allowable 18 feet of head ($F < 18$). The length of 8 5/8-inch tubing required, in units of 1,000 feet, is represented by L_1. Then L_2 is the length of 6 5/8-inch tubing, in 1,000 foot units, and equals 1.786-L_1. From figure 6-6 converting the maximum flow of 928 BPH to 650 gpm and using 8.415 inches (as inner diameter of 8 5/8-inch tubing), the friction loss per mile is 29 feet. Convert this to 5.5 of friction loss (f_1) per 1,000 feet. Similarly, for a flow of 650 gpm and an inner diameter of 6.415, (f_2) is equal to 21.8 feet.

$$18 = L_1\ (5.5) + (1.786 - L_1)\ 21.8$$

Solving for L_1:

$$18 = 5.5\ L_1 + 38.93 - 21.8\ L_1$$
$$16.3\ L_1 = 20.93$$

L_1 = 1.284 thousand ft. of 8⅝-inch tubing, that is, 1,284 feet or 65 standard (20-ft.) sections.

b. Use of Double Lines. If larger pipe is not available, friction loss can be reduced by laying additional pipe parallel to the first and connected to it. A typical problem involving the use of an additional looped line follows:

(1) *Problem.* The conditions are the same as in *a*(1) above. Determine the length of double line necessary to reduce the head loss to 18 feet.

(2) *Principles and equations.* For solution of this problem, use the same formula as used in *a*(2) above. However, before beginning the solution, determine how to compute friction loss (f_1) for the length (L_1) of double line. The principle here is that the rate of flow in each half of a double line is considered to be half that of a single line of the same length.

(3) *Solution.* As previously, the total friction loss must be no greater than the maximum allowable 18 feet of head ($F < 18$). Length of double 6 5/8-inch line required is represented by L_1. Then L_2, the length of one 6 5/8-inch line in 1,000 foot units, equals 1.786-L_1. To obtain f_1, proceed as follows: friction loss for the double line will be that produced by half the emergency rate of flow prescribed in the problem, or 464 barrels per (928÷2). Therefore from figure 6-6, converting 464 barrels to 325 and using 6.415 inches as inner diameter, f_1 equals 31 feet of head per mile, or 5.87 feet of head per 1,000 feet of double line (31÷5.28); and f_2, as before, equals 21.8 feet of head loss for each 1,000 feet of single line of 6 5/8-inch tubing. Detailed solution proceeds as before, substituting—

$$18 = L_1\ (5.87) + (1.786 - L_1)\ 21.8$$
$$15.9\ L_1 = 20.93$$

L_1 = 1.32 thousand ft. of double line, or '132 standard (20-ft.) sections of 6⅝-inch tubing laid in two paralleled lines of 66 joints each.

ˣ6-12. Spacing of Pumping Stations

The most important element in the actual design of military pipeline systems is that of pumping station spacing. Basically, the spacing is determined by the hydraulic design—that is, by the head loss in the pipe for reasons of friction and elevation when the line is operating at the normal capacity for which it is designed. When the line runs uphill, stations are spaced closer. On level terrain, spacing is wider. Where the line runs downhill, the spacing is widest. That mileages between stations are not equal is of no con-sequence. The important factor is that all stations are in balance hydraulically. This is to say that each station in the system must have the same work load to perform.

a. The design factors which determine station spacing include—

(1) Topographic features of the pipeline route.

(2) Type and properties of the design fuel.

(3) The required suction pressures, available head capacities, and other operating characteristics of the pumping units.

(4) The friction head losses for the selected size of pipe.

b. The average spacing of pumping stations on level terrain for various sizes of pipelines, based on normal design conditions, appears in table 6-3.

6-13. Modular Design

Modular design is a simplified graphical method of locating pumping stations (except station No. 1) and pressure-reducing stations. The method is essentially the solution of hydraulic calculations by means of graphs. The graphs required are two: the profile of the pipeline route (para 5-11*c*) and the hydraulic gradient triangle.

a. The hydraulic gradient triangle is a right triangle, constructed on the same scale as the profile. Its altitude (ordinate) represents the available feet of head pressure at the discharge of the design pumping station. Its base (abscissa) represents the distance, in miles, that the discharge head can move fluid against the friction in the pipeline at the normal design rate of flow on level terrain. The hypotenuse of this triangle, the resultant of a vector diagram, is the *hydraulic gradient.* This gradient represents the rate of head loss due to friction for a specific size of pipe, carrying a specific fluid, at a specific rate of flow. If any factor—pipe size, liquid, or rate of flow—is changed, a new triangle must be constructed.

b. Generally, when this triangle is applied to the pipeline profile, with the right angle corner on the location of one pumping station and with the base parallel to the base of the profile, the point at which the hypotenuse (*hydraulic gradient*) or its extension intersects the profile will be the maximum distance to the next pumping station.

c. When tactical considerations dictate more permanent construction of military pipeline systems, or as time permits, results based on modular design should be verified by complete hydraulic analysis.

6-14. Construction of the Hydraulic Gradient Triangle

The triangle is constructed from transparent sheet plastic, cardboard, or paper thick enough so that, after trimming, each edge can be used as a straightedge. A sample construction of a typical hydraulic gradient triangle is illustrated below.

a. Problem. Construct the hydraulic gradient triangle for a pipeline with normal design capacity of 785 barrels per hour. Standard 4-inch, four-stage pumping units and 6 5/8-inch (6.415-inch inside diameter) tubing will be used. The design head capacity of each pumping unit is 465 feet of head. The pipeline profile has the following scale: vertical, 1 inch equals 200 feet; horizontal, 1 inch equals 2 miles.

b. Solution. The triangle, with a 90° angle at A, is constructed as follows:

(1) *Altitude.* The altitude, AB, of the triangle in figure 6-8 is drawn to the same scale as the vertical scale of the pipeline profile. Its height represents the available fluid head in feet at design rate of flow at the pumping station discharge; it is graduated in suitable units, usually 10 feet. Since design capacity calls for only three pumps to operate at one time in the pumping station, the available head capacity will be three times the head capacity of a single pump, or 1,395 feet (465 × 3). This is the altitude of the hydraulic gradient triangle. To scale, its altitude will be 6.975 inches.

(2) *Base.* The base, AC, of the triangle in figure 6-8 is drawn to the same scale as the horizontal scale of the pipeline profile. Its length represents the distance, in miles, that the available discharge head of the pumping station can move the fluid at normal design rate of flow on level terrain. This length is determined by dividing the available head of the pumping station by the friction loss per mile, for the specific tubing, at the specified design flow rate. For the purposes of this problem, the friction loss in 6-

6–36. Tank Farm Pumps and Manifolds

As previously stated, transfer pumps (para 3–19*f*) and tank pumps (para 3–19*e*) operated together, or separately, provide for the movement of petroleum products into, out of, and within tank farms. Also, flood pump units (para 3–19*d*) are used in those tank farms where the required suction pressure (20 psi, para 6–6) at the pipeline pumping station cannot be obtained by gravity flow. Layout and manifolding for various capacity tank farm pump units are shown in TM 5–302. It is to be noted that tank pump units (when used) are located close to the tanks with which they are connected; transfer pumps and flood pumps (when used) are located as close as possible to the tank-farm central switching manifold.

6–37. Switching Manifolds

a. Standard Installations. Necessary switching manifolding (para 3–21) for various sizes of tank farms and tank farm complexes are shown in TM 5–302. Minor modifications depending upon site conditions and possibilities for gravity flow may be necessary. The size of pipe used in the manifold depends on the number and capacity of the tanks in the tank farm or complex and the size of the servicing pipeline. For large tank farms, and at marine (base) terminals where large tankers unload, use 8- or 12-inch manifold and yard pipe. For smaller district- and head-terminal tank farms, use 6- or 8-inch pipe.

b. Design.

(1) Normally, the first tanks in a tank farm are connected by standard manifolding so that the connecting lines to each tank may be extended, and additional tanks can be added to each line, with proper use of pipe, fittings, and valves. The groups of tanks on each line are then treated as a single tank, as illustrated in figure 6–21.

(2) Specially designed manifolds will be found necessary in designing some large tank farms and tank farm complexes. They can be made up of parts of combinations of standard switching facilities, supplemented by additional items as required. To avoid a complete breakdown of the pipeline system when damaged by the enemy, each tank farm in a large complex may be supplied by two branch lines, separately manifolded. Such tank farms are dispersed as described in paragraph 3–32. No dispersion is required within a tank farm, other than normal tank spacing, unless it contains all tankage in a theater or area. In such cases, the tank farm should be split and dispersed to two locations.

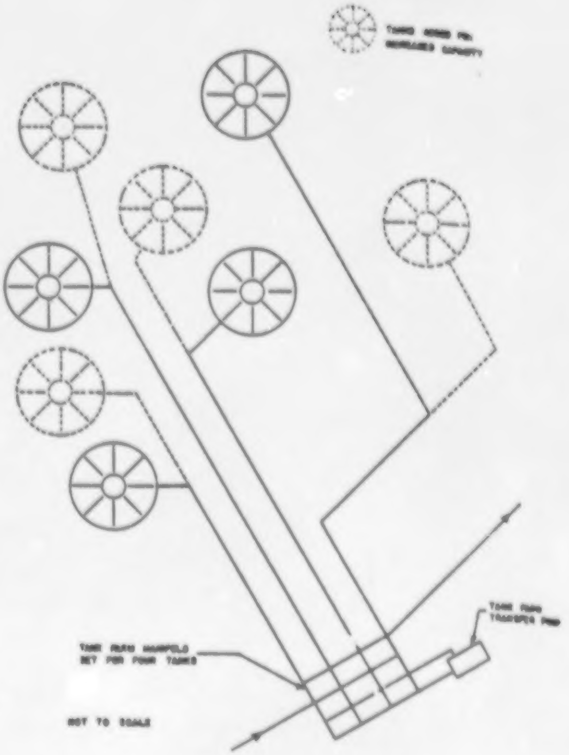

TANKS ADDED FOR INCREASED CAPACITY
TANK FARM MANIFOLD SET FOR FOUR TANKS
TANK FARM TRANSFER PUMP
NOT TO SCALE

Figure 6–18. Extra tanks connected to a standard manifold for additional capacity.

c. Layout.

(1) *Manifold location.* Locate the switching manifold at a low point near the center of the network of tank farm piping with rising grades to all tanks where possible. Minimum distance to any tank should be 250 feet.

(2) *Service lines.* For simultaneous receipt and delivery, as well as transfer to fuel between tanks, provide two service lines to banks of tanks for handling of each type of fuel.

(3) *Tank lateral lines.* Locate lateral lines to run about 40 feet to one side of a tank. They should not run directly to a tank: line expansion and contraction may distort tank plates and cause leakage. Make tank connections from the lateral line through a 90° elbow or tee and an appropriate length of pipe. Plan tank erection so that the tank outlets will permit such connections.

(4) *Main tank valves.* The branch lateral line to each tank should be equipped with two valves: one outside the firewall, and the other (called the skin valve) as close to the tank as possible. Use only steel valves on tank shells.

(5) *Tank farm piping.* All piping within a firewall should be API STD5L pipe, not tubing; when feasible, piping should be welded. Keep piping within firewalls to an absolute minimum.

(6) *Fire protection.* When pumps and manifolds lie within the drainage path of upgrade tanks, construct diversion ditches across the drainage path so as to carry any spillage from tanks around and away from them. DO NOT enclose manifold and pumps in a firewall or revetment, because explosive vapors may collect.

Section V. TANKER UNLOADING FACILITIES

6-38. Background

As previously discussed (para 2-9), either ship-to-shore or dockside facilities in either protected or unprotected waters may be employed for unloading tankers. The design effort needed for unloading facilities depends on the conditions at the terminal site. The availability of existing tanker berths is a controlling factor. Ports are prime military targets, and it is possible that such facilities may not be used for unloading tankers in the future. Offshore unloading facilities will probably be used instead, with the connecting lines coming in over the beach. If port facilities are used, they may require rehabilitation or it may be necessary to construct new ones. Staff level planning in the design of unloading facilities should include consideration of the following variables:

a. Total requirements for POL products on a weekly or monthly basis, including the necessary theater build-up.

b. The draft and size of the largest tankers likely to be used to transport the required bulk POL.

c. The urgency (or speed) of offloading. This may or may not be critical, depending on the tactical situation or possible demurrage on tankers. In general, the facility should be designed to unload the largest tanker expected to use the facility in less than 24 hours, including mooring time. Standard facilities for dock lines, submarine lines, and pump stations are described in paragraphs 3-17, 3-18, and 3-19.

6-39. Location

a. General. In determining the location of tanker unloading facilities, the requirements of the Supply and Maintenance Command must be coordinated with those of the Navy and transportation commands. To protect against the hazards of nuclear weapons and of fire resulting from enemy action, and to avoid port congestion, the tanker unloading facilities should be removed 10 to 15 miles from other port installations. Protection from enemy submarines should be taken into account. When possible, a site should be selected where burning fuel, flowing with a river or tide, cannot spread fire to other facilities. A location in a fairly well protected cove is preferable. In all cases, the variables associated with tanker mooring facilities (par. 6-40) should be taken into consideration.

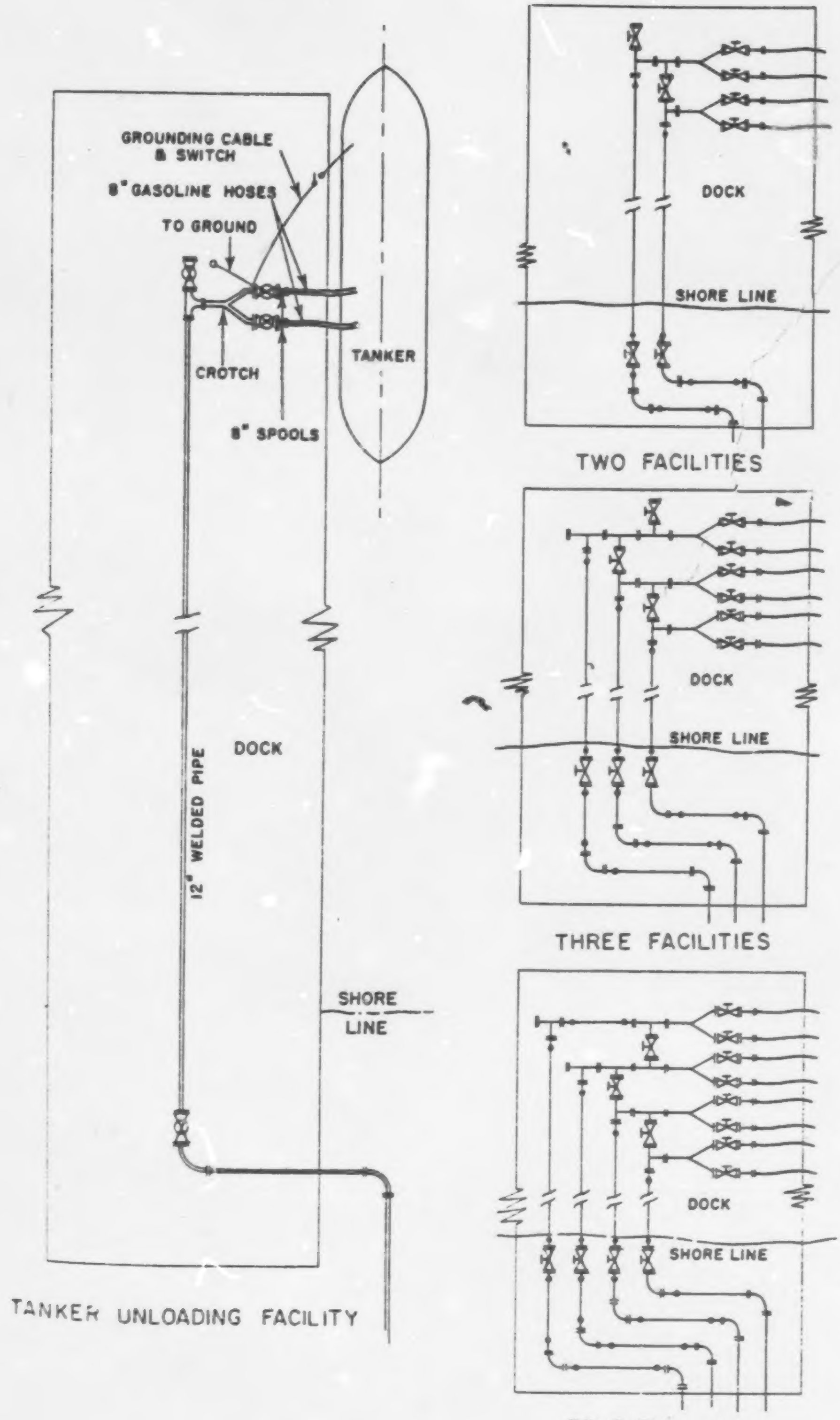
b. Offshore Unloading Facilities.

(1) *Onshore factors.* The offshore unloading facilities should be located in an area with sufficient room for an onshore construction trace 1,500 feet deep (measuring from the shoreline) and 180 feet wide. This area should not have a change of slope (as opposed to slope itself) of greater than 5 percent. The slope (grade) of the trace must be within the capability of the construction equipment. Sufficient space (in addition to that needed for the trace) should also be available for construction of a booster pump station and/or storage tanks.

(2) *Offshore factors.* Offshore unloading facilities should be located at a site suitable for construction of submarine pipelines (par. 6-42) and tanker mooring facilities. Bottom contours and topography should not have a change in slope greater than 5 degrees in order to prevent pipeline damage. Variables affecting mooring design are covered in paragraph 6-40.

6-40. Tanker Mooring Facilities

a. Design Factors. Tanker moorings must be safe for the largest tanker that will use the facility (table 6-5). There must be at least 10 feet of water under the ship's keel for a radius of 1/2 mile at low tide to allow room for maneuver-


GROUNDING CABLE & SWITCH
8" GASOLINE HOSES
TO GROUND
CROTCH
8" SPOOLS
TANKER
12" WELDED PIPE
DOCK
SHORE LINE
DOCK
SHORE LINE
DOCK
SHORE LINE
DOCK
SHORE LINE

TANKER UNLOADING FACILITY

TWO FACILITIES

THREE FACILITIES

FOUR FACILITIES

Figure 6-21. Layout of marine dock facilities for tanker unloading.

CHAPTER 10

PIPELINE PUMPING STATIONS

10-1. Site Selections

In selecting a site for each pumping station in a pipeline system, the following factors must be considered:

a. The site must be located within the limits of the hydraulic design of the pipeline (para 6-12).

b. There must be sufficient space to permit proper location of facilities so as to reduce fire hazards and meet security requirements.

c. The site must be so located as to allow fuel vapors to drain away from the pumping station and not gather in low pockets in the surrounding area. Gasoline vapor is heavier than air. It settles near the ground and flows downhill, forming vapor pools in low areas unless dispersed by wind. These vapor pools present fire and explosive hazards.

d. The site should be located to take the best possible advantage of natural cover and concealment, thereby reducing the amount of artificial camouflage needed.

10-2. Layout

Layout plans for each pumping station are the responsibility of TASCOM headquarters. Such plans give the location of tanks, pumps, and manifolds, with each component numbered in conformity with standard (EFCS, TM 5-302) plans. Modifications of this standard plan for special purposes may be furnished in the TASCOM plan. In addition to copies of the plan furnished the constructing unit, copies also will be provided the operating unit for use by the dispatcher and the operator of each pumping station, with the remaining copies being filed at TASCOM headquarters.

a. Spacing. Troop quarters and pump installations must be separated by at least 100 feet to lessen noise and safety hazards. For security reasons, the separation should not be more than 200 feet. The station fuel supply storage tanks should be so located as to afford proper vapor drainage and to permit gravity flow of fuel to the pumps. Installations and pumps must be so situated as to allow trucks and handling equipment ready access without interference with piping and manifold.

b. Facilities. Shelter must be provided for the 6- to 10-man operating crews at each pumping station, as well as administrative, messing, and latrine accommodations. Pipeline station crews usually will live in tents at the start of operations, unless structures are available on the site. The construction of prefabricated or temporary structures will depend on the permanence of the pipeline and on the availability of construction material. Facilities normally are designed for probable occupancy of 12 months. In the future, possible nuclear warfare may dictate that certain structures be placed underground for protection.

10-3. Pump Sheds

Normally, no pumping station building is required when the pipeline is constructed. However, when the climate makes protection necessary, suitable shelter may be built during the construction phase. A prefabricated, panelized storehouse-type 20 X 50-foot TOE building or similar structure may be used as a pump shed. If such prefabricated structures cannot be obtained, sheds may be constructed of salvage materials. Roof supports and the roof itself, if possible, should be fire resistant; and the roof should be at least 8 feet from the floor. Salvaged pipe may be used for the framework of expedient sheds. Sides are left open for vapor drainage. In bad weather, the windward side may be screened, but a space of at least a foot must be left between the floor and the bottom of the screen for air circulation to prevent accumulation of fuel vapor.